Report on Motors & Motor Controls

These steps will help you pick the right motor for your job . . . p. 91

OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

OCTOBER
1958

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Don't Give Training the Ax 191

For a "Quick Look" at this issue, turn the page . . .

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Volume 37, No. 10 October, 1958

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Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

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A Quick Look

at This Issue

These handy digests permit checking ☑ the articles you want to read first.

SPECIAL REPORT ON MOTORS

☐ **Selecting Motors and Motor Controls . . .** Curves showing how to get motor prices in relation to horsepower, speed, type of enclosure, type of motor and voltages, are included. The trends in motor usage as affected by the API Code RP500 and by recent design changes are discussed. Motor sizes from 1 to 20,000 hp are covered. The article deals only with squirrel-cage and synchronous motors which, of course, are the most common type found in the petroleum processing industry. For complete details turn to **Page 91.**

☐ **New Treating Process in Pilot Stage . . .** Hydrogen treating gets a boost from this pilot plant built for the British Coal Tar Research Association in England. A flow diagram for the process is given. Turn to **Page 104.**

☐ **Three-Stage Unit Improves Crude Split . . .** See how greater product flexibility is achieved with this new three-stage crude distillation unit. Since greater quantities of residual fuel oil can be upgraded to gasoline and furnace oil, you will want to compare the results with your present operation. Turn to **Page 105.**

☐ **A Check List For Plant Layout . . .** Basic principles can be used as a guide to general thinking on plant layout. Whether it's a refinery or petrochemical plant, these tips will help you to attain maximum flexibility and compactness at a reasonable cost. For complete details, turn to **Page 109.**

Please Turn Page ➔

LESS BOILER MAINTENANCE BECAUSE A LJUNGSTROM CUTS SLAGGING

A Ljungstrom air preheater reduces slagging and cuts boiler downtime by boosting combustion air temperature, in some cases by as much as 1000°F. Whatever fuel you use, hotter combustion air makes it burn more cleanly and completely, with less slag and deposits.

More complete combustion also makes standard equipment work at top efficiency, producing more heat from less fuel. One east coast refinery saves $129,000 a year on their fuel bill through increased furnace efficiency. This increased efficiency contributes to an upgrading of the product by 1½ octane numbers, providing an additional annual profit of $58,000.

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Savings like these — where equipment makes a better product . . . lasts longer . . . and costs less to maintain — can pay for a Ljungstrom air preheater *in as little as two years.* Or, if you use the higher combustion efficiency of a Ljungstrom-equipped furnace to increase throughput, write-off time can be cut to nine months!

For further information on potential fuel economy, write today for your copy of a factual article by O. F. Campbell describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

☐ **Applied Hydrocarbon Thermodynamics (Part 9) . . . Generalized Exponents from Entropy Balances** . . . Here in one package are your isentropic exponents as functions of the reduced conditions. Here are 16 graphs for isentropic exponents for values of C_p/C_v from 1.025 to 1.30. Adiabatic and non-adiabatic cases are covered in full. Clip this one fast for your personal file. See **Page 111.**

☐ **Find Latent Heats Quickly . . .** This nomograph, accurate enough for most engineering work, gives latent heats of vaporization for petroleum oils quickly. Here's another timesaver for your design notebook. Turn to **Page 123.**

☐ **Two-Phase Pressure Drop for Horizontal Crossflow Through Tubebanks . . .** How often do you need to make calculations of ΔP for crossflow through tubebanks? Remember the lack of data in the literature on these problems? Well here's the last word and some rapid and accurate correlations for you to start using today. You'll use this one often. Look at **Page 124.**

☐ **How Wrong Can Your Calculations Be? . . .** You may be using the right equations, but your data usually contain inherent errors. Here's an easy way to determine the possible error of your results. Some examples are given to show you how the method works. Turn to **Page 129.**

☐ **Heat Transfer Nomographs (Part 1) . . . Velocity of liquids and gases in tubes . . .** Using this nomograph, the velocity of gases and liquids in standard pipe and tubes can be quickly determined. This is usually the first step in heat transfer problems. These nomographs will form an important part of your data book. Start clipping, turn to **Page 131.**

Your Last Chance to Vote

THIS MONTH is the last chance that you will have to cast your ballot for the one man you think has contributed the most to the Oil, Gas and Petrochemical processing industry. As soon as your ballot is received, the man you named will automatically be nominated for a place in Petroleum Refiner's "Hall of Fame" which is to be a special feature in the January, 1959 Oil Centennial Issue.

There are no special eligibility rules—if you think a man should be included, then all you have to do is write his name on the special postage-paid postcard inside the back cover of this issue. Then simply drop it in the mail. That's all it takes to vote!

Just to give you an idea of who has been nominated so far, here are some of the names. Remember though, these are just a few among the many who have received votes.

George Granger Brown	Vladimir Kalichevsky
William Burton	Donald Katz
Carbon P. Dubbs	Warren K. Lewis
Lazar Edeleanu	Eger V. Murphee
Gustav Egloff	Wilbur L. Nelson
Eugene Houdry	Benjamin Silliman
Vladimir N. Ipatieff	Kenneth M. Watson

Calling All Ol' Timers

IN CONJUNCTION with our special "Oil Centennial Issue" coming up next January, we would like to get the names of PETROLEUM REFINER readers who have been with us since the start—way back in 1922. Our files are not complete in this respect but we know there are some who have been reading PETROLEUM REFINER for these past 37 years. And if you're one of them, we'd like to have you drop us a card saying so and indicating your "starting" date.

That first edition in September, 1922, was only 32 pages thick and was called "The Refiner and Natural Gasoline Manufacturer." But if you're one of the ol' timers we're looking for, you already know that!

We also would like to hear from those who have been reading PETROLEUM REFINER for, say, 25 years or longer. Although your friendship doesn't date all the way back to the 1922 birthdate, you're still an old-enough ol' timer that we want your name, too.

If you think you qualify as a PETROLEUM REFINER ol' timer, then we think so, too—so just drop a card or letter to:

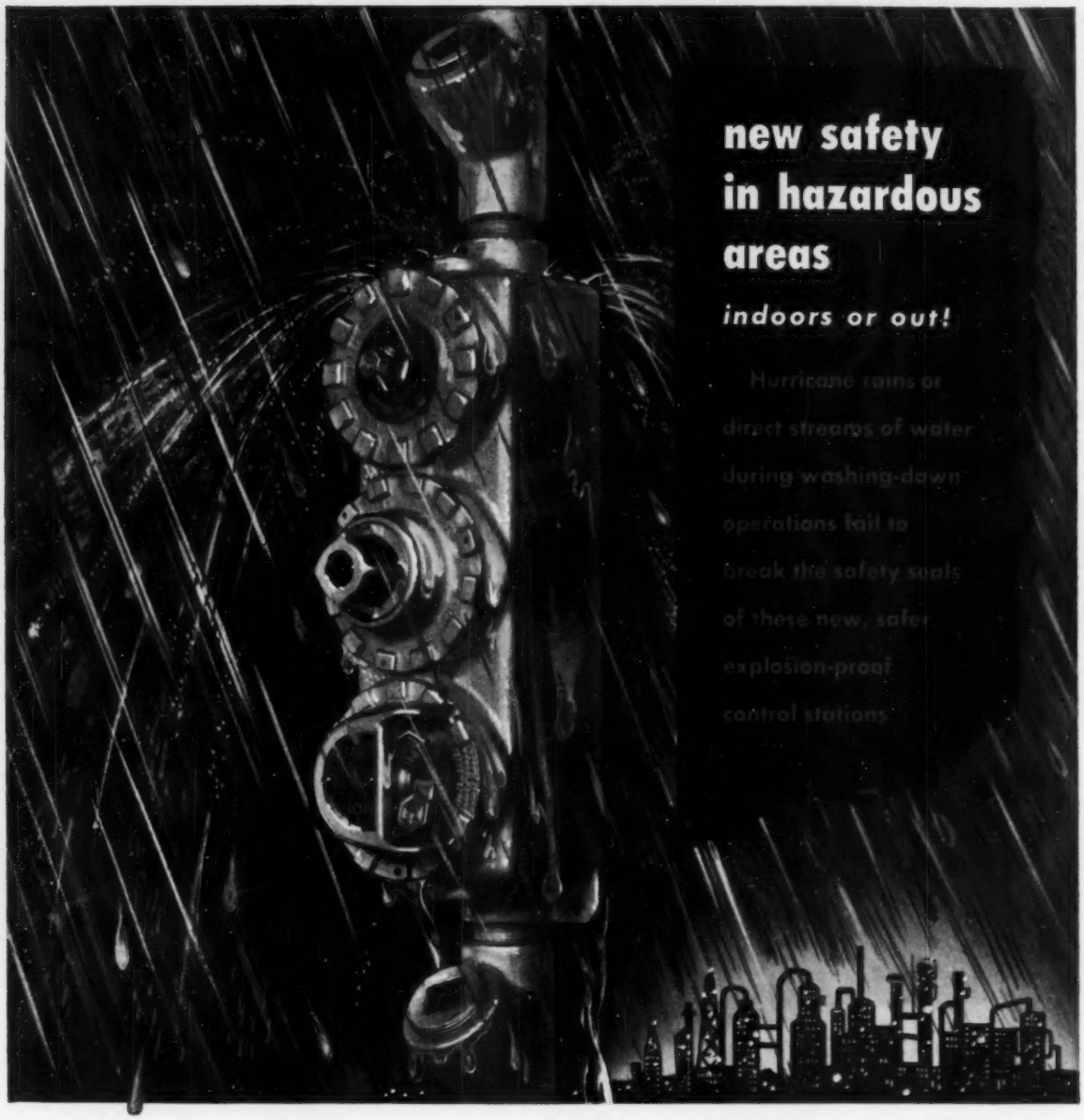
Centennial Editor
PETROLEUM REFINER
P. O. Box 2608
Houston 1, Texas

☐ **What it Costs to Operate a Unifiner . . .** Here are direct operating cost data on four typical Unifining units. These units vary in size, use, and location to cover a wide range of applications. Now you may better predict the cost of using this type of process. Look on **Page 133.**

☐ **Don't Give Training the Ax! . . .** Often a company is wiser to accelerate training efforts rather than curtail them when faced with necessity of cutting costs. If there is proven need for training and the program is sound and practical, then it is shortsightedness on the part of management to cutback or eliminate training. Quite often it is the very tool which could cut plant costs. You'll get the full story by turning to **Page 191.**

☐ **Prepare Yourself for Inventing . . . How to Invent (Part III) . . .** Even though most inventions come from the workings of the subconscious, it is the conscious mind which supplies the materials the subconsciousness works with. Here are some fundamentals that will furnish those materials and will improve your ability to invent. **Page 196.**

☐ **Relax, You'll Live Longer . . .** It has been proved that the worker who is full of tension becomes fatigued quicker, and is more apt to have an accident. Here are a few hints which will help you to relax and forget some of the pressures created by day-to-day existence. Turn to **Page 199.**



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PETROLEUM REFINER and The **REFINERY CATALOG** for the oil, gas and petrochemical processing industry.

WORLD OIL (formerly The Oil Weekly) and The **COMPOSITE CATALOG** for the drilling-producing industry.

PIPE LINE INDUSTRY and The **PIPE LINE COMPOSITE CATALOG** for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

★★★★★ for November

NOVEMBER'S Petrochemical Development Issue of PR is designed to help readers keep abreast with important changes in this field. New developments, for instance in synthetic rubbers include *cis*-polyisoprene, just on the verge of commercial development as well as *cis*-polybutadiene. Then, the possibilities of butadiene, right now in excess production, is discussed by one of its leading producers. Acetylene from hydrocarbon sources continues to grow and merits an article dealing with the newest commercial process for its manufacture. (Added here is a complete description of the process equipment as well as expert suggestions for transportation of acetylene within a petrochemical plant.) This one issue will contain these *plus* authoritative articles on 1) aromatics as sources for petrochemicals, 2) latest angles on xylene separation methods and 3) growth of the petrochemical industry in Europe, just to list three. So you see we have ample reason to tag it a "Development Issue." We figure if we can update readers on changes taking p'ace these days we're doing a genuine five-star service.

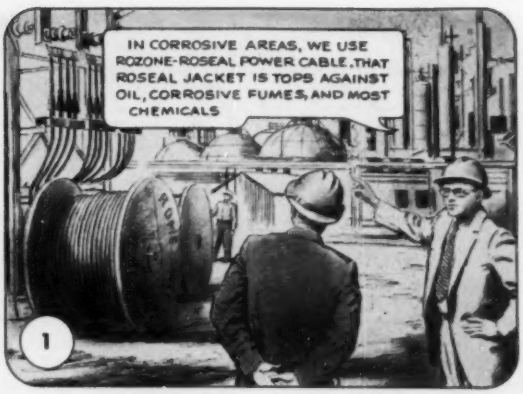
May We Present . . .

EVEN THOUGH IT APPEARED on this page last month (incidentally, for the first time in any of our publications) we ask the privilege of making this formal presentation. It's the company insigne, the Gulf Publishing Company brand so to speak, seen to the left just under the picture of our several publications. Hereafter this neat arrangement of the company initials above an open magazine or book will appear on all of our products. And we hope that within time it will become well known throughout the length and breadth of the land especially in oil and publishing circles. To borrow somebody's phrase, it always may be accepted as the hallmark of highest quality. So be it magazine or book thus branded, we hope you get as much satisfaction out of the ownership as we did in its production.

Other People's Mail

LIKE TO READ other people's mail? Don't be bashful about admitting it if, secretly, your answer is yes. We say don't be bashful because it is pretty generally believed that there are very few literates in the country who don't sneak a look when they have the chance. Well, here is a case where you not only *can* but you are *urged* to do just that. Reference is to the editor's Mail Box which in each issue of PR appears on the page just before "Look Box." (This issue it's on Page 82.) Printed in this spot each month are interesting excerpts or full letters on matters which we think would interest you. So you are invited to read them. And, more important, we'd like to hear from you whenever you have an idea on a timely topic of interest to the processing industry.

DANGER! CORROSION AT WORK...


IN CORROSIVE AREAS, WE USE ROZONE-ROSEAL POWER CABLE. THAT ROSEAL JACKET IS TOPS AGAINST OIL, CORROSIVE FUMES, AND MOST CHEMICALS
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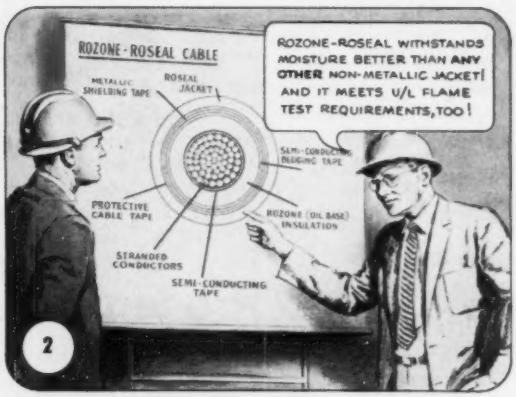

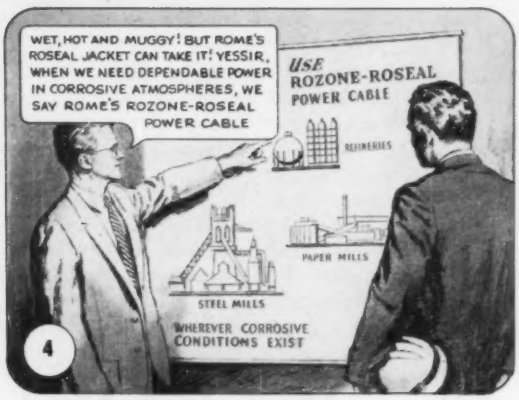
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USE ROZONE-ROSEAL POWER CABLE
REFINERIES
PAPER MILLS
STEEL MILLS
WHEREVER CORROSIVE CONDITIONS EXIST
4

A matter of FACT

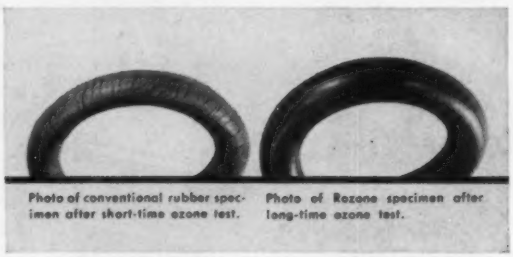

Photo of conventional rubber specimen after short-time ozone test. Photo of Rozone specimen after long-time ozone test.

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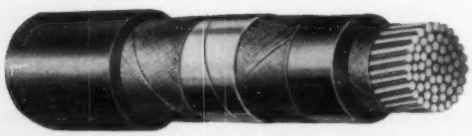

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A Quick Look at the Industry THIS MONTH

The New Import Plan—Some Win, Some Lose . . . Government bared new voluntary imports plan for all east of Rockies and unless there are revisions, refiners will have to live with it. Plan isn't perfect (ask Atlantic and Tidewater) but is simple, clear-cut, and easy to administrate. Works like this:

- First six months of '59, each refiner gets not less than 6 percent nor more than 37½ percent of his capacity.
- Last half of '59, each gets quota not less than 9 percent of throughput. Those with highest percentage allocations will be cutback to allow others to increase to 9 percent.
- Starting in 1960, all refiners get same percentage of runs—figure to be revised every six months.
- Importers of asphaltic and Canadian crudes have built-in protection.

But some companies are hurt. Atlantic Refining president pulls no punches in saying his company won't comply unless plan is changed to recognize individual cases. Hard-hit Tidewater contends plan favors inland refiners and is based on questionable principles.

Other critics say program:

- Severely cuts back companies which years ago spent millions building foreign production.
- Hands quotas on silver platters to refiners with no foreign production and no use for foreign oil.
- Allows inland refiners legally to accept quotas of "cheap" foreign oil strictly for profitable resale—without even seeing oil.
- Encourages excessive refinery runs since quotas will be based on average throughput.

There's the plan—but look for slight changes.

Latest Research Trend . . . More industrial companies (government, too) turning to nonprofit research institutes for services. Stanford Research Institute officials reports combined volume of nine leading research institutes in 1950 quadrupled by 1957—$24 billion vs. $100 billion. This compares with only $560,000 in 1930. Why the trend? Two reasons: special skills and fresh approaches.

Plastic Scrap Market Plaguing Producers . . . Reclaimed plastic from toothbrushes, squeeze bottles, etc., is price squeezing virgin material. Scrap merchants process the stuff, sell it 8 or 9 cents a pound cheaper than fresh polyethylene. "It's murder," moans one chemical firm.

Detroit Scraping Fuel Injection . . . As reported in "Quick Look at Industry" last March (page 126) fuel injection is headed for scrap-heap—will be almost nonexistent in new cars. Only Chevy will offer fuel-feeding system which originally claimed more zip along with fuel economy. But actual benefits didn't justify $400 price tag.

Heating Oils May Be Scarce . . . Middle distillates supply looks short as heating season approaches. But refiners, facing gasoline glut, aren't hurrying to produce more heating oil which would aggravate situation. Also, demand is expected to rise by

10 percent—and crude stocks are low. To top it off, experts predict colder-than-normal winter.

Jet Fuel Battle Shaping . . . Looks like kerosine is winning over gasoline-type fuel JP-4 in proposed sales to commercial jet airliners. Choice is based on safety plus fact kerosine is tax-free—but many refiners think advantages are not real. Why? For one thing, Congress will probably tax kerosine used in jet-liners same as it taxed JP-4.

American Airlines expects its 110-plane fleet of Boeing 707's, Convair 600's and Lockheed Electras will use 450 million gallons fuel annually by end of '62.

Tar Sands Profit Picture Unchanged . . . Another look at Alberta's tar sands shows little change in economics of producing this crude substitute in Alberta and piping it to Superior, Wis. Profit per barrel still figures around 40 cents, as reported in Blair report about 8 years ago. This means investment return of approximately 5.5 percent.

Western Canadian crude is also big obstacle to immediate development of the Alberta deposits.

Hydrogasification of Shale . . . Institute of Gas Technology engineers can now convert Colorado oil shale to high-quality fuel gas. Called hydrogasification, method economically produces gas with 800 Btu per cubic foot heating range. This is near natural gas; higher than most manufactured gas. Initial studies show process uses 90 to 100 percent of organic matter as opposed to shale-to-oil's lesser 80 percent.

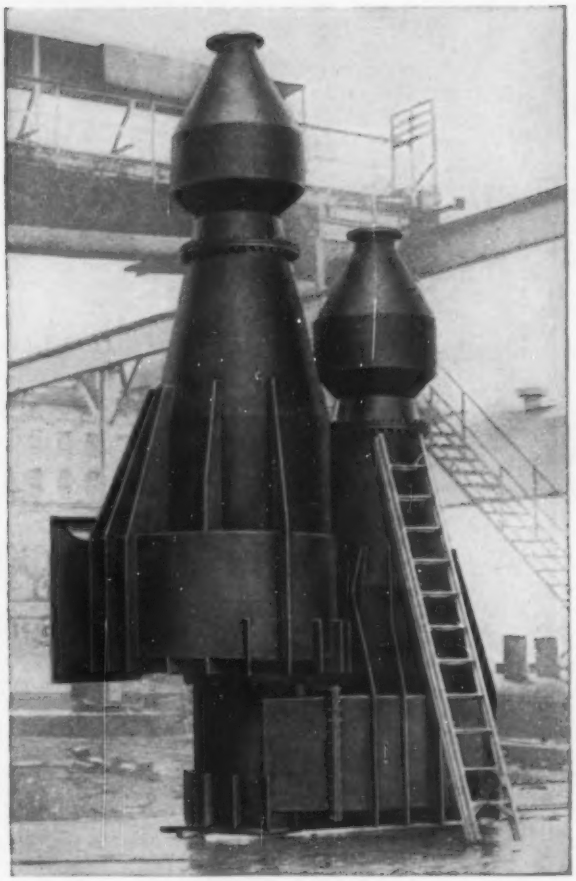
Competition Keeps Getting Tougher . . . Latest contention is recent slowdown in growth-rate of chemical industry was not due to lack of capital, but because of nothing left for firms to invest in. Whenever new and promising areas appear, many jump in at once—including non-chemical firms. One example: polyethylene. One result: much product, little profit.

Canadian Gas Liquid Production Rising . . . Experts estimate in 1982, gas liquids production from Canada's prolific gas reserves will reach 370,000 bpd; sulfur, 27,-200 long tons daily. This compares with present U. S. gas liquids production of 820,000 bpd and 19,000 daily tons sulfur. Twenty-three processing plants now operating in Western Canada—developed mostly to meet dewpoint limits and gas conservation laws.

Heavier Alcohols from New Plant . . . Conoco planning large alcohol plant based on new method for making heavier alcohols from petroleum. Process makes use of early Ziegler work—will produce in 6 to 18 carbon range.

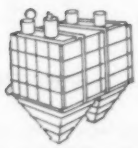
Quick Look Around the World . . . New studies suggest oil is not formed by chemical changes due to underground temperature and pressure, but by groundwater washing soluble compounds out of sediments . . . **Signal Oil and Gas and Hancock Oil** agree to merge . . . **Harvard scientists working in Aramco's** Saudi Arabia lab make discovery which may aid eye disease research . . . **Petroleum industry cleanest** in world says Los Angeles Air Polution committee.

New Nuclear Tool Available . . . Latest analytical technique which bears watching is "Nuclear Magnetic Resonance." Technique provides insight into composition of hydrocarbon-containing samples. Also gives ability to "see" structure.

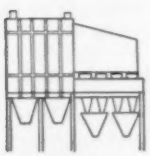


Exploring new frontiers!

BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS

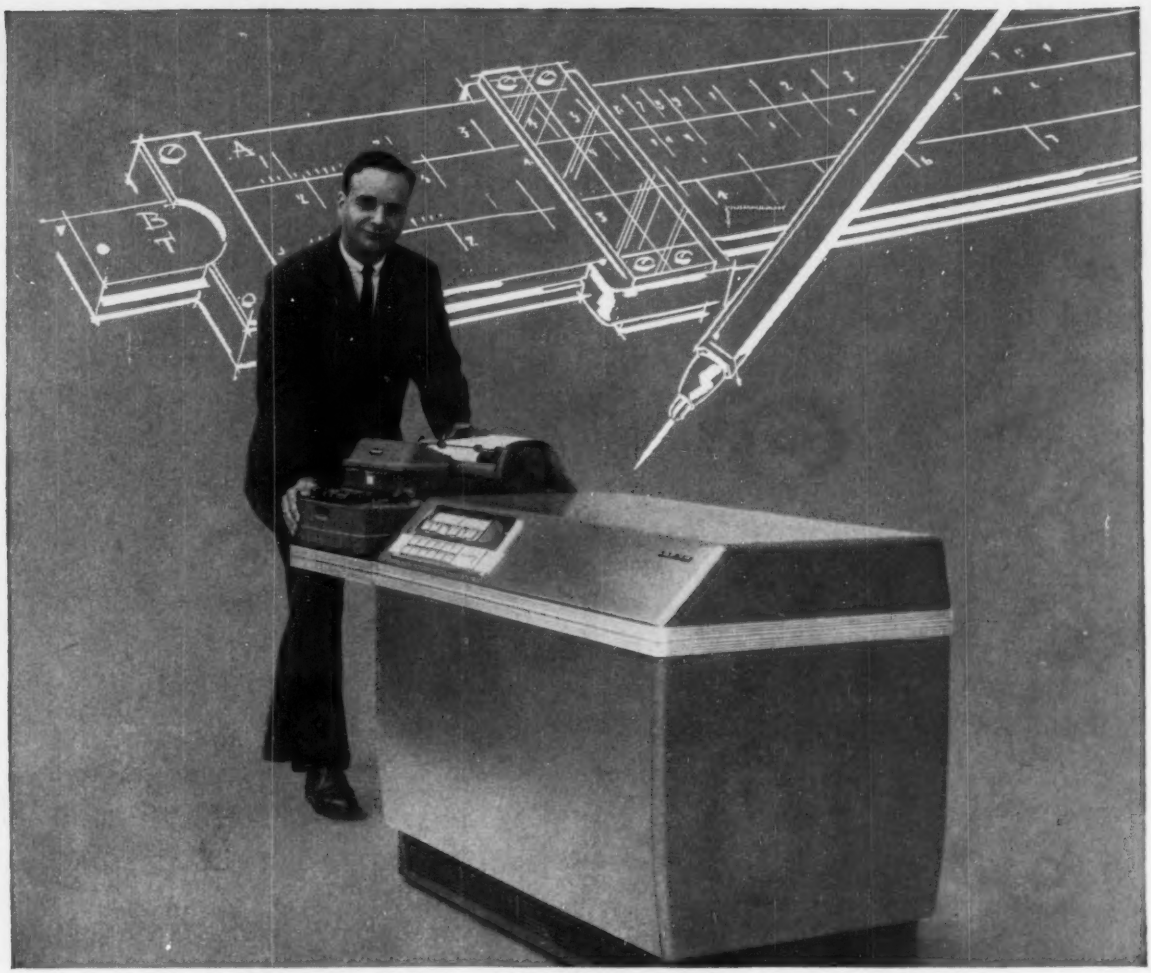


PRECIPITATOR-CYCLONE COMBINATIONS

But these aren't satellite launchers, though they're specially designed for high temperature operation: they're Buell extra-efficient cyclone dust collectors . . . and the new frontiers they're exploring are in industry. Everywhere in American industry, from cement mills to refineries, from chemical plants to power generating stations, Buell collectors set new records in percentage of dust removed, low maintenance, and improved plant operation. Even in the age-old field of fly ash collection, Buell extra efficiency pays off. Only *Buell* cyclones have the unique Shave-off port that traps small fines in the double eddy currents. And Buell large-diameter design eliminates bridging, clogging, or plugging. *All three* Buell Systems are illustrated and described in "The Collection and Recovery of Industrial Dusts". Write for a copy to Dept. 21-J, Buell Engineering Company, Inc., 123 William St., New York 38, N. Y.

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**



Now! On-site linear programming at high speed with this powerful electronic computer

ROYAL PRECISION LGP-30

Here's the mobile, stored-program electronic computer with large capacity...direct print-out of answers

Compact, completely mobile . . . Royal Precision LGP-30 will today furnish you with high-speed electronic computation *wherever you want it* – give you more time for *creative* engineering. And at the lowest cost ever for a complete computer system!

Unusual capacity. Operating from any convenient wall outlet, the self-cooled LGP-30 allows you to work your linear programming *on site.* Used *right at your desk* for any other problem, LGP-30 gives you the greater flexibility of stored-program operation...speed, memory (4096 words) and capacity comparable to equipment many times its size and cost. (In one application, for instance, LGP-30 handled a linear program with as large a matrix as 46 x 27.) Answers are printed out directly in a format which requires no deciphering.

Simple to operate and program. LGP-30's controls are so simplified, even non-technical personnel are quickly trained. Programming is easily learned. A library of sub-routines, plus programs for a wide variety of applications, are available.

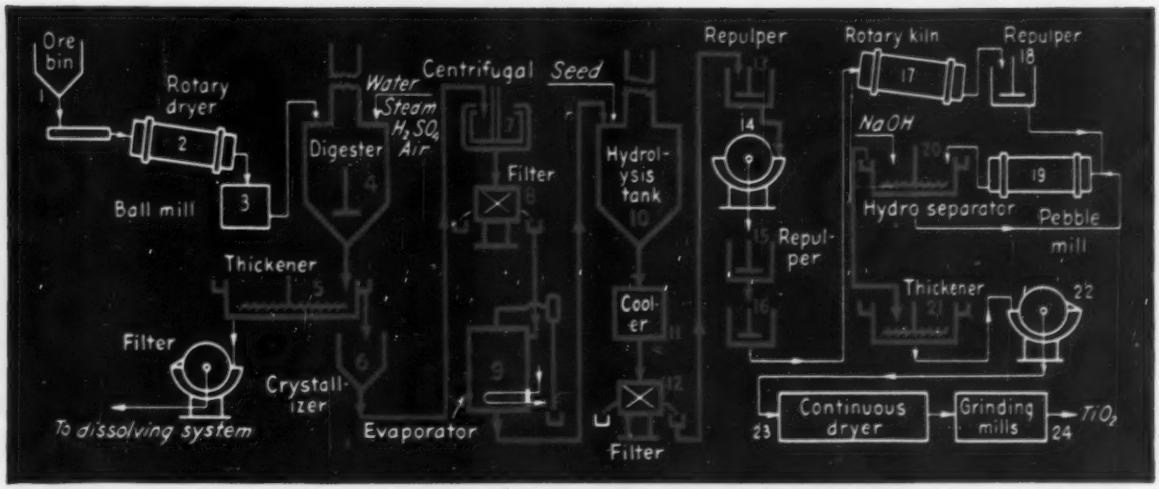
Wide scope of petroleum applications. Among the jobs for which LGP-30 is now being widely used in the petroleum industry are: pipeline problems, mass spectrometer problems, analysis of oil field production, flash point calculations, pumping and batching scheduling, correlation of seismic records, reservoir engineering studies and well-logging interpretations.

Exceptional value; complete service. Smallest initial investment ever for a complete computer is combined with low operating and maintenance costs. Service facilities are available coast-to-coast.

For further information and specifications, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE

data processing division



HOW *lead is used to control corrosion*

in Titanium Dioxide Production Equipment

TiO_2 is not corrosive. But H_2SO_4 is a real metal-eater . . . *first* on the attacking line in the production of TiO_2.

First on the defensive line, however, is *lead*, dependability itself when it comes to combating many corrosive chemicals.

Lead reacts on contact with H_2SO_4 and other "corrosives" to form an insoluble, impermeable film. This film adheres to the metal surface . . . stopping or slowing down further reaction or attack.

Starting with digesters, where ilmenite ore is treated with sulphuric acid, *lead* is a steady defender . . . as lining for vessels and tanks, valves and pumps, in heating and cooling coils, in centrifugals and filters. It is used in combination with steel, concrete, wood or brick in many of the steps in the manufacture of TiO_2.

And bear this fact in mind: the use of *lead* cuts down-time. *Lead* lends itself to prompt, low-cost repairs. In case of leak or lesion, the affected area may be fixed quickly, with minimum loss of production. And . . .

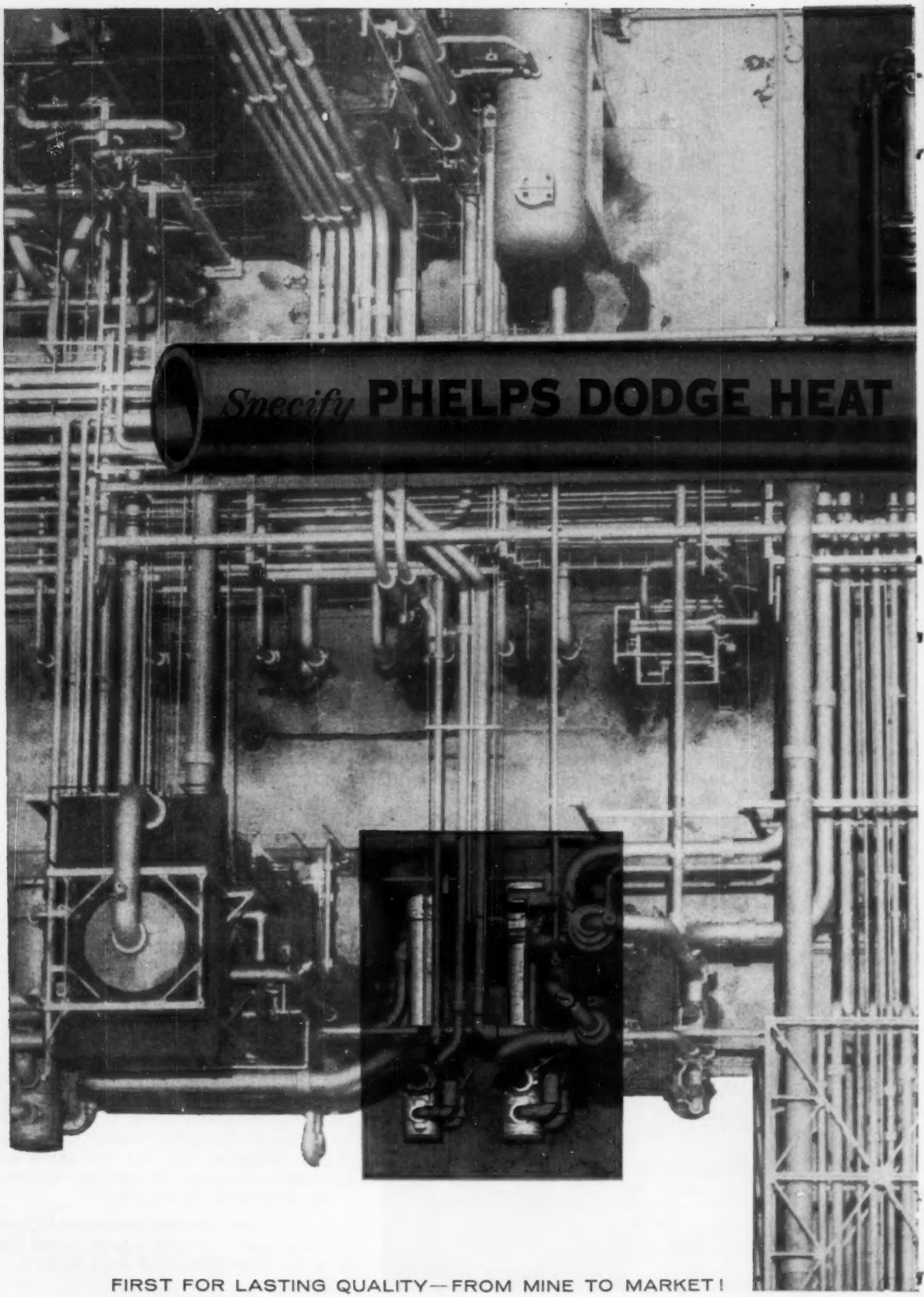
. . . when you think of Lead . . .

think of National Lead

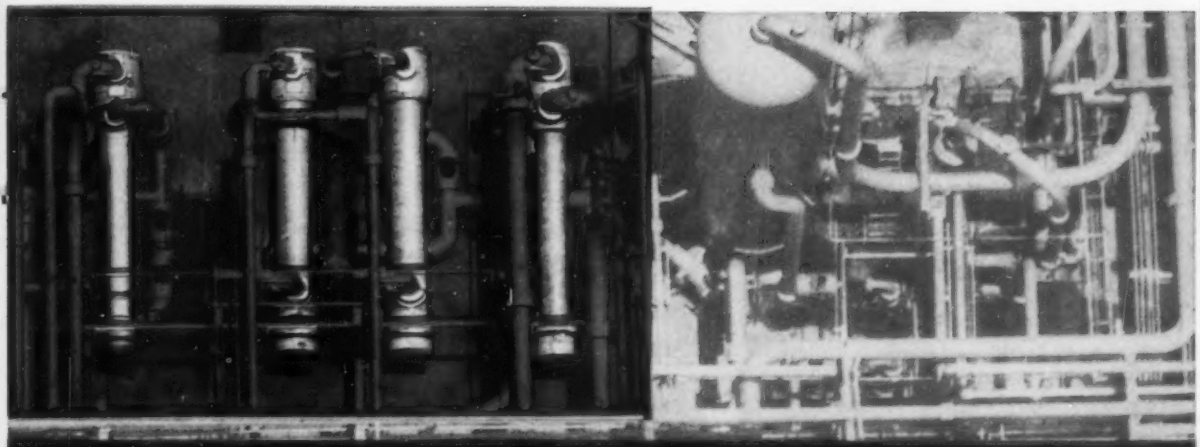
National Lead's long experience in bringing *lead* and steel together . . . in acid-handling lines, in complex, massive process, storage and shipping vessels . . . is at your service. When *lead* and steel are bonded together in this equipment, the union is stronger than *lead's* tensile strength. Cracking of the lining, due to vibration, pressure and rapid cyclic temperature changes, is held to a minimum. Creep is virtually eliminated.

Perhaps *lead* can save you money. Contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, N. Y., for information.

For more data on advertised products, use Readers' Service Cards, last page.

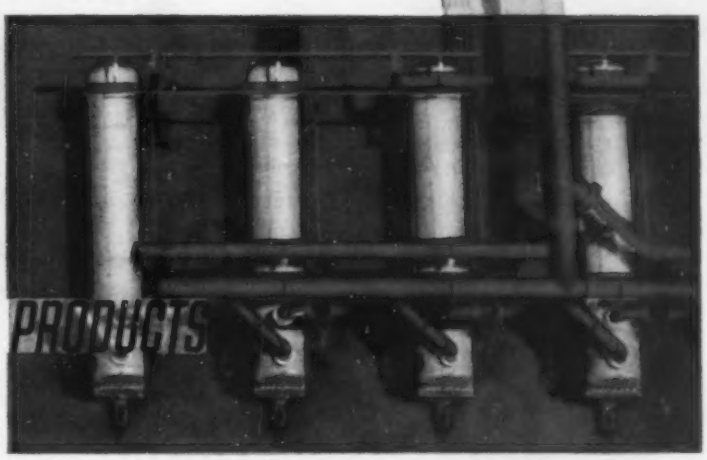


FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



EXCHANGER TUBES *for Longer Service!*

- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.



PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D.C.

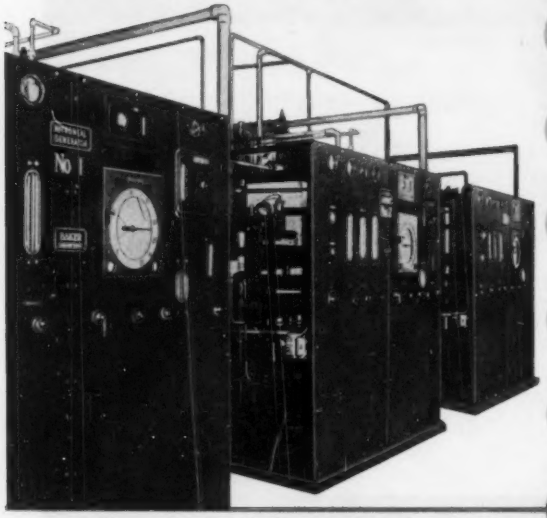
For more data on advertised products, use Readers' Service Cards, last page.

for the most efficient production of oxygen-free gas

NITRONEAL® GAS GENERATOR

. . . provides by far the most economical and efficient method for the production of pure nitrogen —*completely free of oxygen*—and with hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Nitrogen is supplied at a fraction of cylinder supply cost.

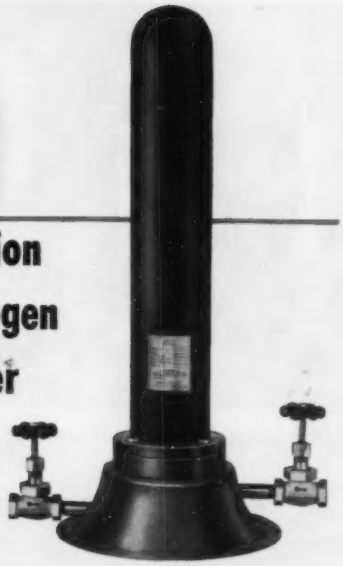
The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of



rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. Units can be supplied in capacities of 100 cfh to 10,000 cfh. . . . The catalyst lasts indefinitely—maintenance costs are practically nil. Write for complete catalog material and data.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

low cost catalytic purification of hydrogen and other gases



This Deoxo Purifier permits low cost catalytic purification of hydrogen and other gases. Oxygen is removed to less than one ppm. Operation is extremely simple and without cost. No maintenance, reactivation, auxillary heating or water cooling required. Write for DEOXO catalog.

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high purity fused quartz

Fused quartz laboratory and production equipment, including standard apparatus, crucibles, trays, cylindrical containers in a full range of sizes as well as tubing up to 25" diameter are available for early delivery.

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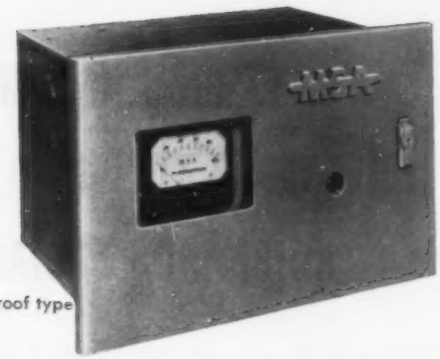
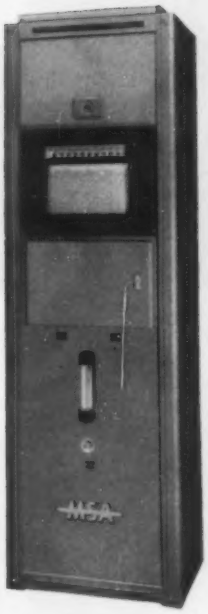
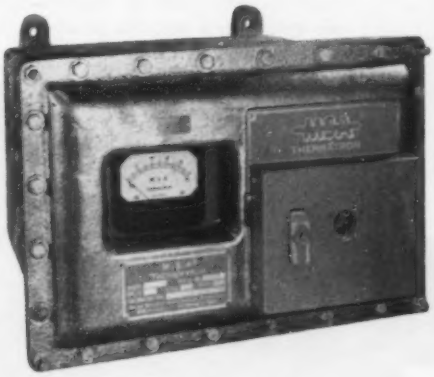


Non-explosion-proof type

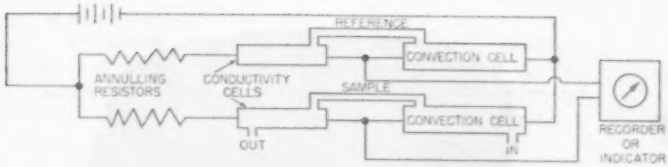


A non-explosion-proof type of M-S-A Gas Thermatron with recorder mounted in cubicle

Explosion-proof type



M-S-A® Gas Thermatron continuously analyzes for one component in multi-component gas mixtures



Schematic Flow and Wiring Diagram

This unique development in gas analysis instrumentation combines thermal convection and thermal conductivity effects to provide selective measurement of a single component of a mixture without "scrubbing out" interfering components.

MSA has been applying its knowledge of gas analysis to specific customer problems for over 30 years. Latest and most unique solution to some of these problems is the M-S-A Gas Thermatron.

This unit selectively analyzes for one component of at least a ternary mixture of gases (without removal of any component) by employing both thermal conductivity and thermal convection properties of the gas.

Other standout features: Calibration is possible over very narrow or very wide ranges (0-100% Gas). Construction is rugged. Operation is stable. Maintenance is simple, infrequent. High accuracy and speed of response are inherent characteristics.

In process control, you can use the selective M-S-A Thermatron for analysis of components in hydrogenation, ammonia synthesis, hydrocarbon synthesis and other processes.

In the area of atmosphere/combustion control, you can analyze for CO_2 or H_2 in atmospheres containing H_2, CO_2, N_2, CO and water vapor. Or, for CO_2 in flue gases.

And where gas purity is a factor, the M-S-A Thermatron is helpful in the analysis of argon, hydrogen, helium or water vapor in oxygen, air or nitrogen.

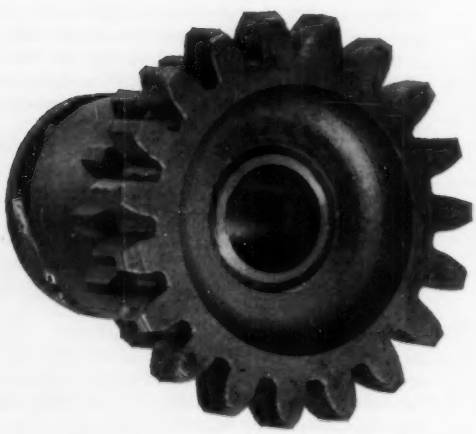
The MSA Instrument Specialist will welcome an opportunity to relate these advantages to your specific operation. Contact him soon. And write us for informative new bulletin on this inexpensive thermal conductivity analyzer.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

MSA

CORROSION REALLY STOPPED!



Gears and pistons were used to illustrate the damage of corrosion more vividly. The basic idea of the ASTM Steam Turbine Oil Test in which probes are ordinarily used was not changed.

ARMOUR DUOMEENS®
OFFER COMPLETE PROTECTION AGAINST CORROSION!

Here you see 2 pistons and gears after 20 hours in a modified ASTM Steam Turbine Oil Test. The piston and gear in the "control" oil-brine solution were badly corroded. *There was no corrosion on the lower piston and gear when only 60 ppm Duomeen salt was added to an identical solution. Both parts stayed as shiny and clean as when the test began!*

It is hypothesized that the Duomeen plated-out on the metal surface as a closely-packed mono-molecular film, enabling the surface to become preferentially oil-wettable. By such action, a highly effective diffusion barrier is formed, even at very low concentrations, which acts to inhibit corrosion.

Versatile Duomeens make all refinery products function better

Because these oil soluble organics are selectively adsorbed from oil to metal, they function as product additives, process corrosion inhibitors, and as chemical intermediates.

Diesel oils, lube oils, aviation gasolines, greases, automobile gasolines, #2 fuel oils—all can benefit from the Duomeens and other fatty amine derivatives in the following ways . . .

- Corrosion inhibitors in refinery products
- Sludge inhibitors in fuels and oils
- E.P. lubricants in hi-pressure oils and greases
- Oiliness agents in oils and greases
- De-icers in gasolines

These di-polar surface active agents are also being utilized in many other applications.

Refineries are using them as corrosion inhibitors throughout the entire refining process. Because of their adaptability, they have few equals when used as chemical intermediates. And new uses are still being discovered for the Duomeens.

Armour petroleum specialists will help you utilize the right organic for your finished products, your flow lines and equipment. There is a Duomeen—or a Duomeen derivative—specifically designed to solve almost any refinery problem.

Send for the new Duomeen booklet, product samples and application information.

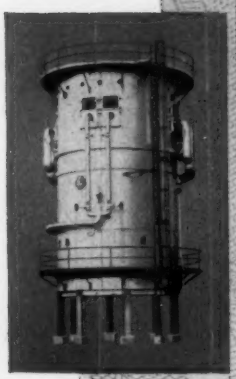
ARMOUR CHEMICAL DIVISION

Leader in Progressive Fatty Acid Chemistry

Armour and Company • 1355 West 31st St. • Chicago 9, Ill.

HYDROGEN FROM NATURAL GAS

for producing AMMONIA and METHANOL



Since its introduction ten years ago, the Chemico *gas reform furnace* has often proved the most efficient and economical first step in the production of ammonia, methanol and high purity hydrogen from natural gas. The unique design of the Chemico *gas reform furnace* eliminates thermal expansion problems, assures easy control during operation and requires minimum maintenance.

Now there are more than 60 furnaces in operation, and another 10 are in the design or construction stage. These units range in capacity from 50,000 to 8,000,000 standard cubic feet per day of hydrogen plus carbon monoxide. For any process which requires hydrogen, the Chemico *gas reform furnace* may well prove the most economical means of obtaining the necessary quantities. Write to Chemico for further information.

WRITE TODAY FOR A COPY OF THE NEW CHEMICO GENERAL BULLETIN

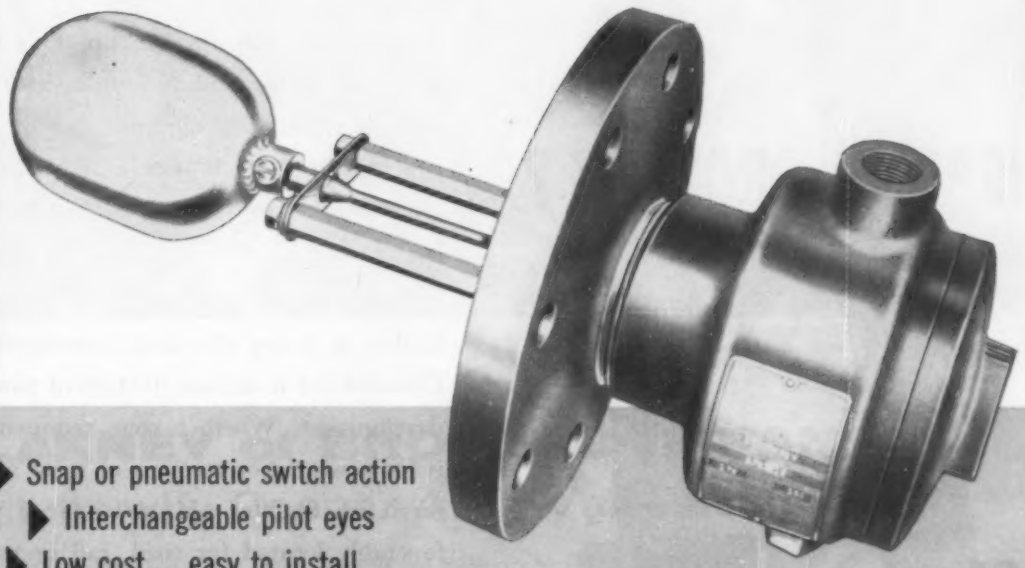
CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

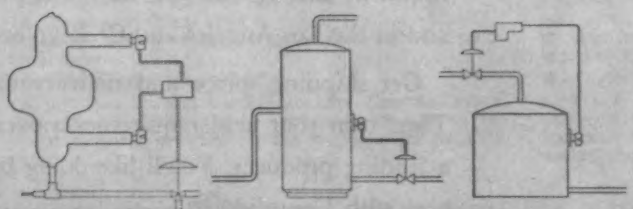
CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

Series 2800—The oil man's Level Controller for Lease Automation

FISHER



- Snap or pneumatic switch action
- Interchangeable pilot eyes
- Low cost... easy to install



Type 2806-252V controlling level of volumetric measurement vessels for accurate control of liquid volume.

Separator or line scrubber control

High level shut-in control in tank farms

252V HOUSING ASSEMBLY

Sizes—4" iron or steel, flanged, with ratings up to 900# ASA. Available with coupling type, welding type or screwed bar housing. Float size 3½" x 6" stainless steel. Pressures up to 1000 psi. Solid plastic available for pressures over 1000 psi. Flexure tube—K Monel.

PILOT ASSEMBLIES

Type 2800—Explosion-proof electric switch assembly—snapping range—3/16"—1" with 1.0 specific gravity liquid. Electrical rating—20 amp., 125, 250, 440 volt AC. Color coded wiring.

Type 2806—Pneumatic relay with snapping range of ½" to 1¼", with 20 psi air supply.

Type 2807—Pneumatic relay for throttling service. Available with horizontal or vertical floats for wide range of proportional band requirements.

The float actuated 2800 series is a low cost, snap acting liquid level control available with either electric (explosion-proof) or pneumatic switch action. Pilot is interchangeable on float housing assembly. Features the stab-in type of tank mounting for easier installation.
Write for Bulletin F2800 for complete information.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

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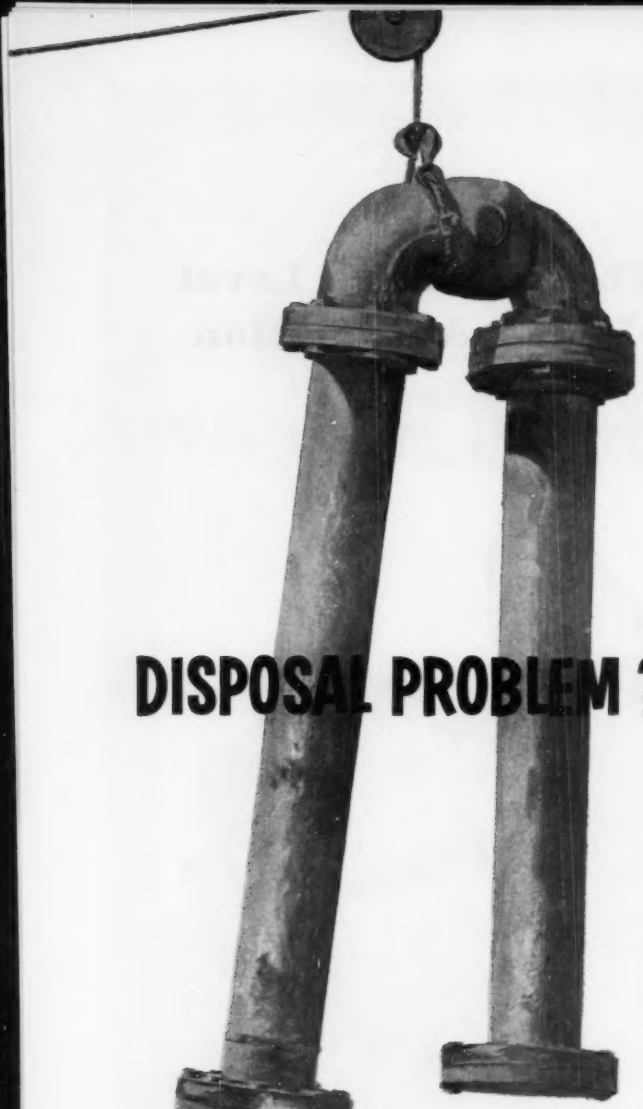
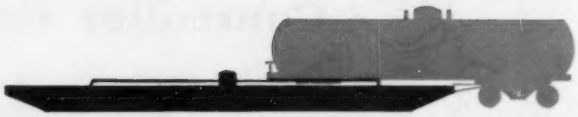
FISHER® Controls

SINCE 1880



let Consolidated handle your sludge acid



DISPOSAL PROBLEM ?

Consolidated Chemical Industries will take your sludge acid and return it to you as fresh, white, 99% sulphuric. Costly? Just the contrary—you'll turn a liability into an asset. Acid recovery is good business for *everybody.*

Such a service is typical of the technical facility in heavy chemicals developed by Consolidated in almost 40 years of pioneer development. Whether your requirement is for new acid or recovery of spent acids, there are Stauffer plants to serve you, favorably located for road, rail or water shipment throughout the Gulf Southwest and in the Los Angeles and Chicago areas.

Get shipping, price and delivery data. Then turn your acid requirements over to a leading producer. You'll like doing business with Consolidated.

Stauffer CHEMICALS SINCE 1885

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CONSOLIDATED CHEMICAL INDUSTRIES DIVISION

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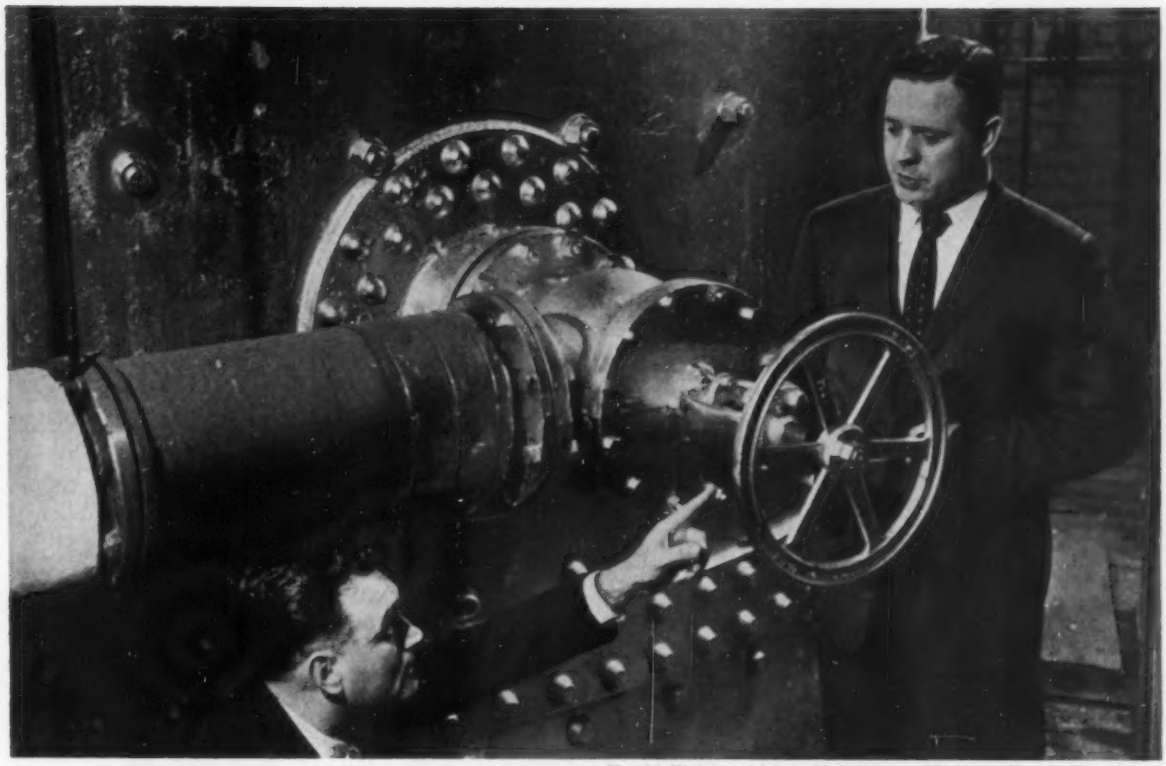


Harold Blakney (right), Maintenance Manager, Brown Company, Berlin, N. H. Left, Frank Hiltz, Vice President Brown Wales Co., Cooper Alloy distributors, Auburn, Me. Center, Cooper Alloy 8" angle circulating valve on digest tank.

BLAKNEY of BROWN COMPANY

tells why Cooper Alloy Valves suit him

Q. *Mr. Blakney, why does Brown Co., a leading manufacturer of pulp, paper, and other forest products, use stainless valves and fittings in its mills?*

A. Because stainless steel is one of the few materials that can take the tough corrosion punishment of pulp mill digester fluids.

Q. *Why Cooper Alloy valves?*

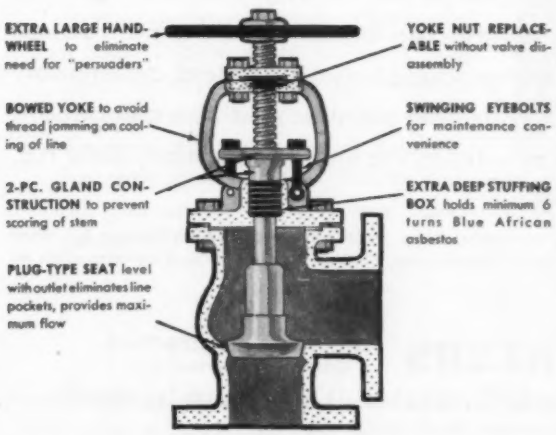
A. For long life and low maintenance. Over the years Cooper Alloy valves have proven themselves to be extremely well designed for the tough service we give them.

Q. *How, specifically?*

A. Well, these 8" angle valves, for example, have that extra-deep stuffing box to give a tighter stem seal. The seat, level with the outlet, eliminates line pockets and provides maximum flow. These plus extra large handwheel all give me less maintenance problems.

Q. *Anything else you like about Cooper Alloy valves?*

A. Yes, I like the engineering service available from Cooper Alloy we have had occasion to use, and the fine fast delivery and service we obtain from Brown Wales' nearby warehouse.


EXTRA LARGE HAND-WHEEL to eliminate need for "persuaders"
BOWED YOKE to avoid thread jamming on cooling of line
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
PLUG-TYPE SEAT level with outlet eliminates line pockets, provides maximum flow
YOKE NUT REPLACEABLE without valve disassembly
SWINGING EYEBOLTS for maintenance convenience
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos

A VALVE DESIGNED FOR STAINLESS! The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* Check the Special Design Features shown at left.

As the little CA man below is saying: "*You can tell a Cooper Alloy Valve as far as you can see it!*" Write today for *your* copy of our folder "Valves and Fittings in the Pulp and Paper Industry." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

Corporation • Hillside, New Jersey

FOUNDRY PRODUCTS DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

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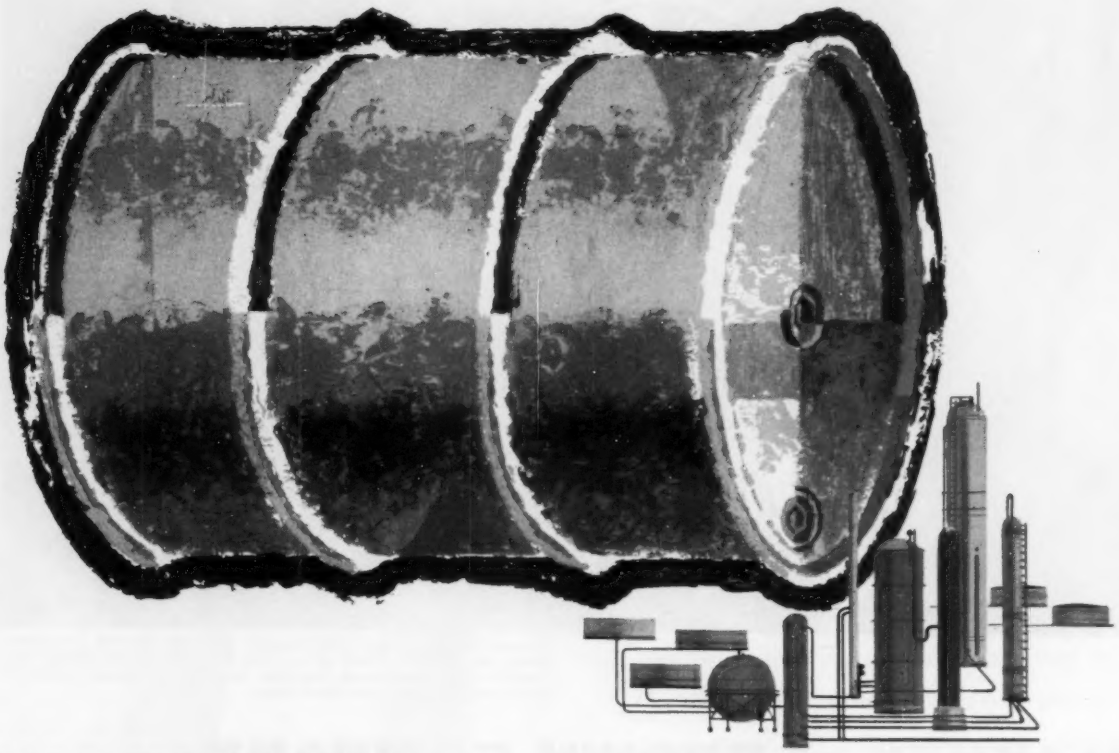
call KE for plant expansion or new facilities



INGENUITY has made KE a leader in refineries and petrochemical plants. For Shell Oil—a multi-million dollar platinum catalyst reformer. For American Gilsonite—coke calcining and off-site facilities. For Texas City Refining—a moving bed catalytic cracker. These are typical of the demanding assignments that Ingenuity brings to Kaiser Engineers. KE can take your refinery project from initial concept through completion. Economic analysis, site selection, process and mechanical design, procurement, expediting, construction, start up—KE does one or all. Throughout, KE ingenuity works to shorten construction time, reduce costs and produce a more efficient, dependable facility. Your next plant or addition can benefit this way—from ingenuity in action. Call KE.

Ingenuity in Action. New multi-million dollar platformer for Shell Oil Company, Wilmington, California. Design and construction by Kaiser Engineers.

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SAVE manpower

SAVE money

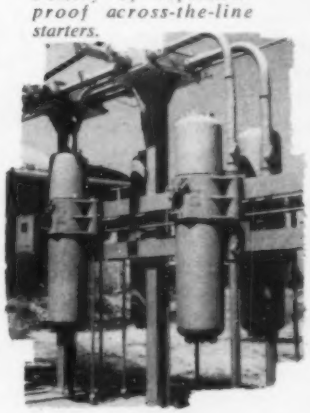
SAVE with Safe, Automatic Power

SAVE maintenance

Automatic convenience of safe electric power assures thrifty service as you need it.

To provide highest continuity of service at lowest possible cost for this refinery, Purchased Electric Power is used providing safe, dependable, automatically operated preferred-alternate 12KV power service. Typical explosion-proof load center for delivery of 480 volt power to processing and cooling pumps are shown at extreme right. Wherever you need safe, automatic power at lowest possible cost, call your nearest Utility Electric Power Company . . . or write us.

Battery of explosion-proof across-the-line starters.



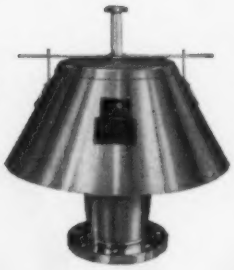
Safe electric load center

Purchased Electric Power . . . saves money, manpower, maintenance and serves you better automatically

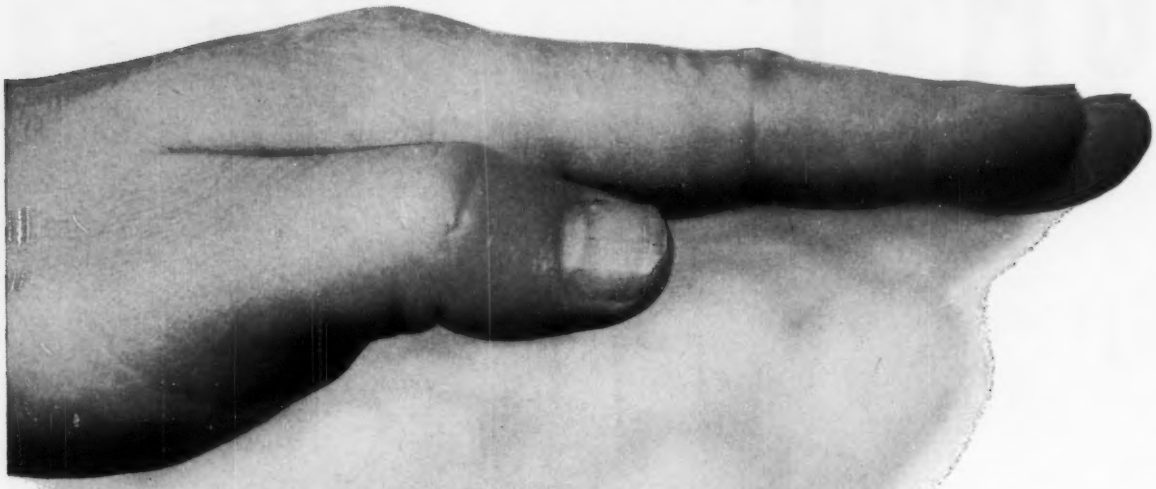
Petroleum Electric Power Association

P.O. BOX 35006, DALLAS 35, TEXAS

new **S&J** *Breather Valves*



Materially Reduce Storage Tank Vapor Loss



New Shand and Jurs model ST-9749 diaphragm-type breather valves are a major achievement in storage tank venting and vapor conservation. They provide resistance to sticking, corrosion and freezing never before offered. In addition they require practically no maintenance feature non-wetting teflon-on-fiberglas diaphragms for maximum performance and longer life; completely eliminate critical drain holes or other areas that require continuous checking. Ruggedly built from aluminum and stainless steel, ST-9749 breather valves are lightweight, and already available in 4″, 6″, 8″, and 10″ sizes. Call your nearest S&J branch office or sales representative for Technical Bulletin 52D-ST-9749 Breather Valve.

SHAND AND JURS

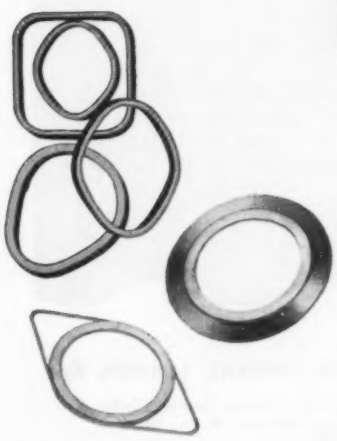
GENERAL PRECISION EQUIPMENT CORPORATION GPE

2600 Eighth Street, Berkeley, California
Branch offices and representatives in principal cities

A subsidiary of General Precision Equipment Corporation

Teflon* SPIRAL WOUND GUARDIAN† GASKETS

for high temperatures and pressures



GUARDIAN Gaskets are made in round, oval, square, flat side, diamond and pear shapes in practically any size. Thicknesses ⅛", .175", and ¼" depending on application. Centering devices include a steel ring type to assure accurate positioning and to avoid excessive compression. Also, loop type centering guides are available which fit over opposite bolts.

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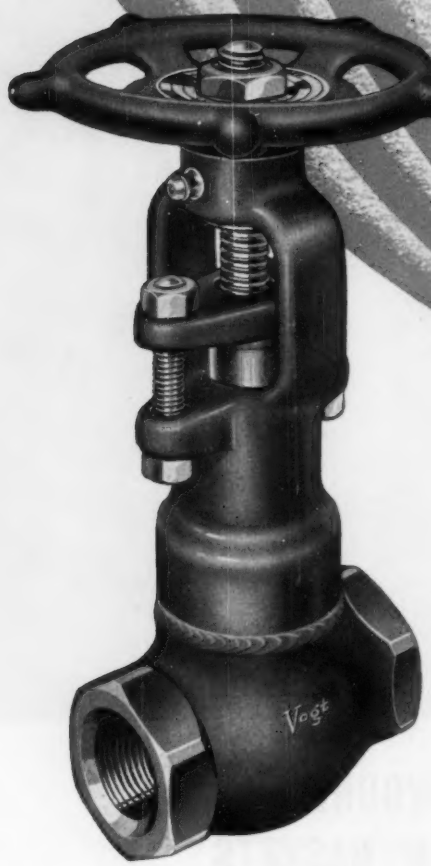
*Dupont Trademark †Garlock Trademark

Another addition to the Vogt line of TOP QUALITY valves . . .



Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

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The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

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Illustrated

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Both series identical in dimensions and have 13% chrome stainless steel trim.

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VALVES

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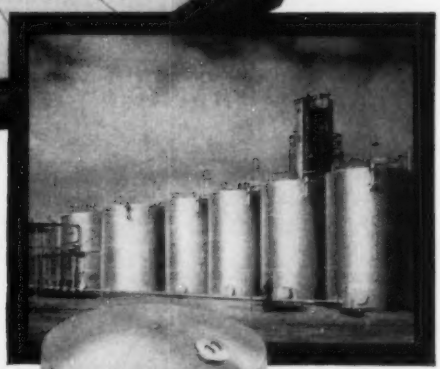

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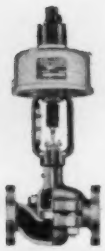
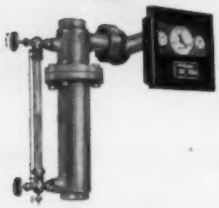
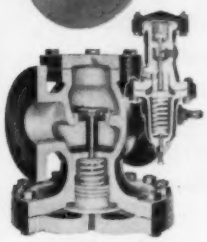


SPLIT-BODY VALVES



LEVEL CONTROLLERS



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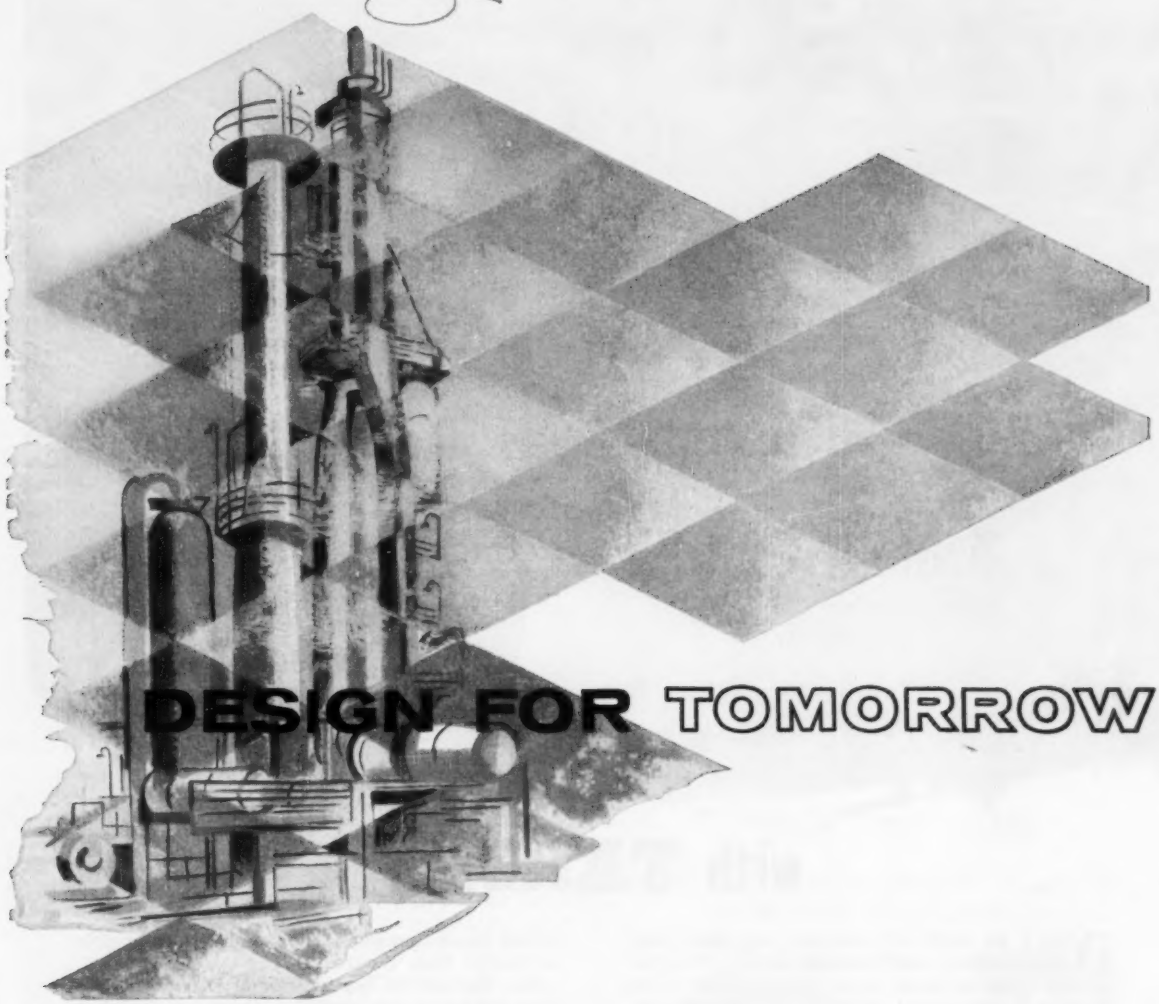
intangibles were never so **important**



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The time is past when a petroleum, chemical or petrochemical plant could be built to meet immediate needs. In this fast-moving field it must be designed and built with an eye to tomorrow. Flexible interpretation of plant design and broad experience in building for the future are important intangibles included in Procon service. That is why a Procon-built plant performs well today and yet can be readily adapted to the changing demands of tomorrow.

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Rockwell-Nordstrom is the world's most complete line of lubricated plug valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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You can if they're Rockwell-Nordstrom lubricated plug valves. Since the lubricant is actually an instantly replaceable soft seat . . . you literally can reseat in seconds while the valve is in service for only a penny's worth of lubricant.

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ROCKWELL-Nordstrom VALVES

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insulation was supplied

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BURMA *at Syriam*
for The Burma Oil Co. (1954) Ltd.
Main Contractor: Foster Wheeler Ltd. (London)

CANADA *at Clarkson, Ontario*
for British American Oil Co. Ltd.
Main Contractor: The Lummus Co.

COLOMBIA *at Cartagena*
for International Petroleum Co. Ltd.
Main Contractor: Bechtel Corporation
(Insulation Contractor: Harold Aber & Co.)

ECUADOR *at La Libertad*
for the Anglo-Ecuadorian Oil Co. Ltd.
Main Contractor: Procon (G.B.) Ltd.

ENGLAND *at Kent Oil Refinery*
for The British Petroleum Co. Ltd.

FRANCE *at Raffinerie de Normandie*
for Compagnie Francais de Raffinage.
Main Contractors: Kellogg International Corporation and Foster Wheeler Ltd. (France).
(Insulation Contractor: Soc: Technisol).

IRAQ *at Daura, near Baghdad*
for Iraq Government Oil Refinery Administration.
Main Contractor: Foster Wheeler Ltd. (London).

ITALY *at Genoa*
for Raffineria Dottore E. Garrone.
Main Contractor: C.T.I.P.

KUWAIT *at Akmadi*
for the Kuwait Oil Co. Ltd.
Main Contractors: Bechtel-Wimpey and E. B. Badger & Sons Ltd.

THE NETHERLANDS *at Pernis*
for N. V. de Bataafsche Petroleum Maatschappij.

NETHERLANDS ANTILLES
at C.P.I.M. Refinery, Curacao
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Bingham

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FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor or liquid to atmosphere or leakage from outside into pump is *impossible*. Not only is plant and personnel protected but loss of valuable pumpage is prevented. Type KC High-Pressure Single-Stage Stuffingboxless Pump illustrated.

NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300° F). Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850°F and higher also can be handled. These conditions present no difficulty for Bingham Stuffingboxless Pumps, but they are difficult and sometimes impossible to meet with conventional pumps due to limitations imposed by the stuffing box.

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Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

***And other volatile liquids.**

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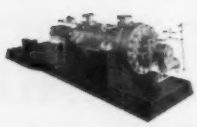
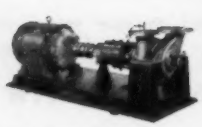
The Bingham Type HPD "Double Volute" Multi-Stage Double Case "Hi-Press" pump for extremely high pressure service.

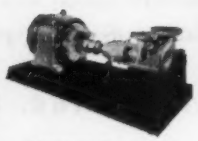
Bingham Type VS Single-Stage Wet-Pit Pump for high capacity, medium head service.



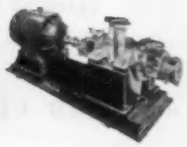
Bingham Type CP "Double Volute" Multi-Stage, Double-Case pump for hot or cold service.



A Bingham Type CKA "Double Volute" Single-Stage Koke-Krusher for coke-laden pumpage.



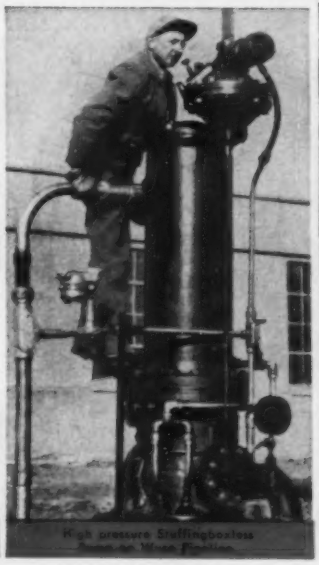
Bingham Type CAD "Double Volute" Single-Stage Process Pump.



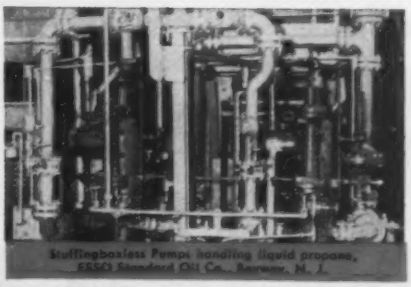
Bingham Type CM vertically split-case two-stage pump for hot service.

LIGHT HYDROCARBONS* SUCTION PRESSURES

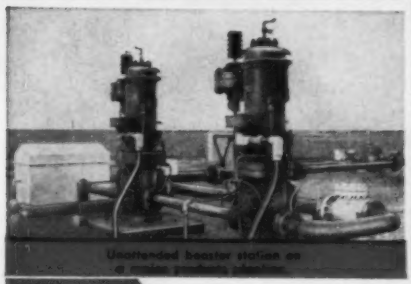
High Pressure Stuffingboxless Pumps, Stanolind Oil & Gas Co., Sunray, Okla.



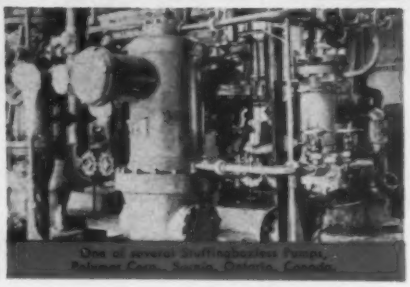
High pressure Stuffingboxless Pumps on Wash Fractions



Stuffingboxless Pumps handling liquid propane, ESSO Standard Oil Co., Bayway, N. J.



Unattended booster station on oil mixed products pipeline



One of several Stuffingboxless Pumps, Polymer Corp., Sarnia, Ontario, Canada

Partial List of Refineries Using Bingham Stuffingboxless Pumps

British American Oil Co., Ltd.
Carbide & Carbon Chemical Co.
Canadian Investors, Ltd.
Cities Service Company
Creole Pipe Line Company
E. I. duPont de Nemours & Co.
ESSO Standard Oil Co.
Great Lakes Pipe Line Co.
Gulf Oil Corp.
Imperial Oil Company Ltd.
Polymer Corporation
Phillips Petroleum Co.
Stanolind Oil & Gas Co.
Sinclair Oil Company
Sohio Petroleum Co.
Standard Oil Company of Indiana
Tennessee Gas & Transmission Co.
Tide Water Associated Oil Co.
Texas Company
Warren Petroleum Co.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**
Factories: **Portland, Ore. • Vancouver, B. C., Canada**

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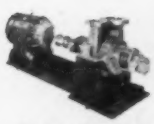
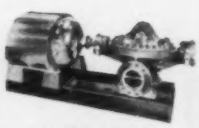
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

PUMPS FOR PETROCHEMICAL SERVICE



Bingham Type CD "Double Volute" Double Suction vertically-split case pump for hot service.

Bingham Type CJ "Double Volute" Two-Stage Process Pump.



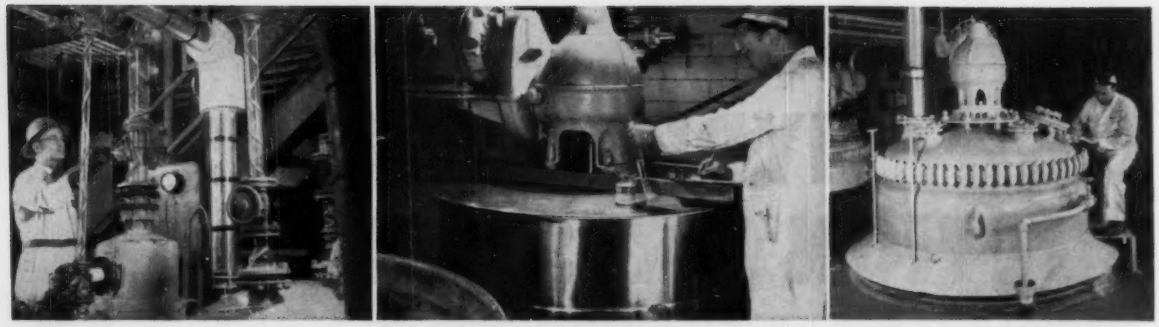
Bingham Type HSB "Double Volute" Double Suction Pump for high heads.

Bingham Type MSB Horizontally Split-Case Multi-Stage Pump for high pressure hot or cold service.

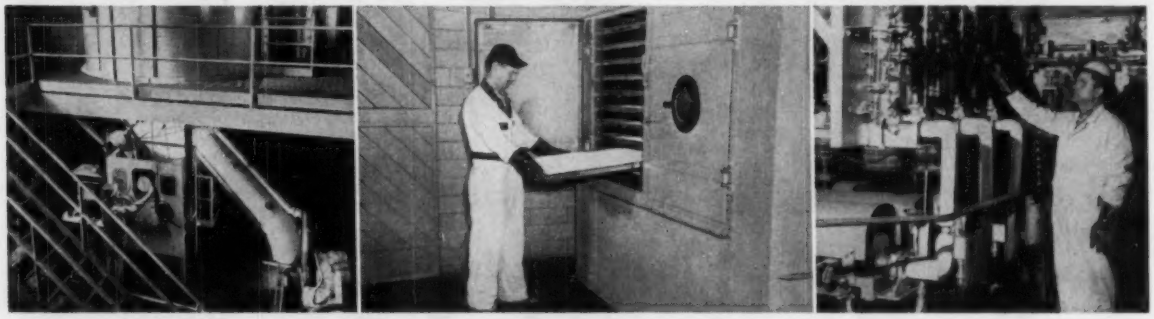
Bingham Type KT Stuffing-boxless Pump for high suction pressures and cold service.

Bingham Type VCP Vertical Pump for low NPSH conditions, featuring bottom dismantling.

For more data on advertised products, use Readers' Service Cards, last page.



Made to measure . . . *and made to measure up!*



B&A® "Custom-Made" Chemicals

Special chemicals for virtually every need! Leading companies in many chemical processing fields regularly call on B&A's "custom-made" chemical service. One reason is the equipment you see here—typical of Baker & Adamson's modern, versatile facilities. These companies avoid many problems *and save money* by depending on B&A's *established* production facilities rather than manufacturing their own special chemicals.

How you save: When your new and special chemicals are custom-made for you by B&A, you save capital investment in plant and equipment . . . save on staff additions, too. You use your own production to best advantage—while B&A meets your special chemical requirements *exactly*, with dependable deliveries scheduled as desired.

B&A has the equipment, the experience, the skill you need! Baker & Adamson offers over 1,000 high purity chemicals . . . available in quantities ranging from small bottle lots of laboratory reagents to tank car and carload shipments of fine chemicals. This versatile manufacturing ability is at your service when you call on B&A for "custom-made" chemicals.

For a confidential discussion of your needs and how we can serve you, phone or write your nearest B&A office.

BAKER & ADAMSON®
Fine Chemicals

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland (Miss.) • Cleveland (Ohio) • Denver Detroit • Houston • Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.) • Providence San Francisco • St. Louis • Seattle • Kennewick, Vancouver and Yakima (Wash.)

whenever

water

enters

the picture . . .

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

BETZ LABORATORIES INC., Philadelphia 24, Pa.

SPECIAL REPORT ON

PETRECO

Electric Lube Oil Treating

Low installation costs range from $60 to $100 per barrel of daily throughput

WHY PETRECO LUBE TREATING DOES A BETTER JOB

1 **Petreco Lube Oil Treating outmodes conventional treating systems,** such as batch and centrifugal. It is automatic, precision-controlled, continuous. Petreco Lube Oil Treating changes lube treating from an "art" to a *science*.

2 **Petreco Lube Oil Treating eliminates guesswork.** It eliminates the problems and uncertainties of gravity settling. It eliminates the high equipment cost and maintenance headaches of centrifugal treating. It incorporates the many advantages of automation. Because the lube stock is *intimately* contacted with acid, less acid is used, and is *made to work harder*. Intimacy of contact is possible with Petreco because all the elements in the treatment—temperature, pressure, amount of acid, degree of mixing intensity, and contact time—are predetermined and automatically controlled. The acid-lube oil contact time is precise because, with Petreco, separation is "right now".

FIELD PROVED

Petreco Lube Oil Treaters are currently in use by two of the largest refiners in the United States. Reported advantages of Petreco Lube Oil Treating are:

1. **Continuous**
2. **Automatic**
3. **Minimum Contact Time**
4. **Lower Acid Requirements**
5. **Re-use of Acid Sludge**
6. **Oil Not Exposed to Atmosphere**
7. **Sludge Can Be Pumped**
8. **Negligible Oil Entrainment in Sludge**
9. **Minimized Sludge Disposal Problem**
10. **Low Operating and Maintenance Costs**
11. **Employee Training Simplified**
12. **No Air Pollution**

Get better lube products, with less operating attention, low capital investment, minimum operating cost . . . get Petreco.

Write today for the Petreco Lube Oil Treating Booklet. Complete information is yours for the asking.

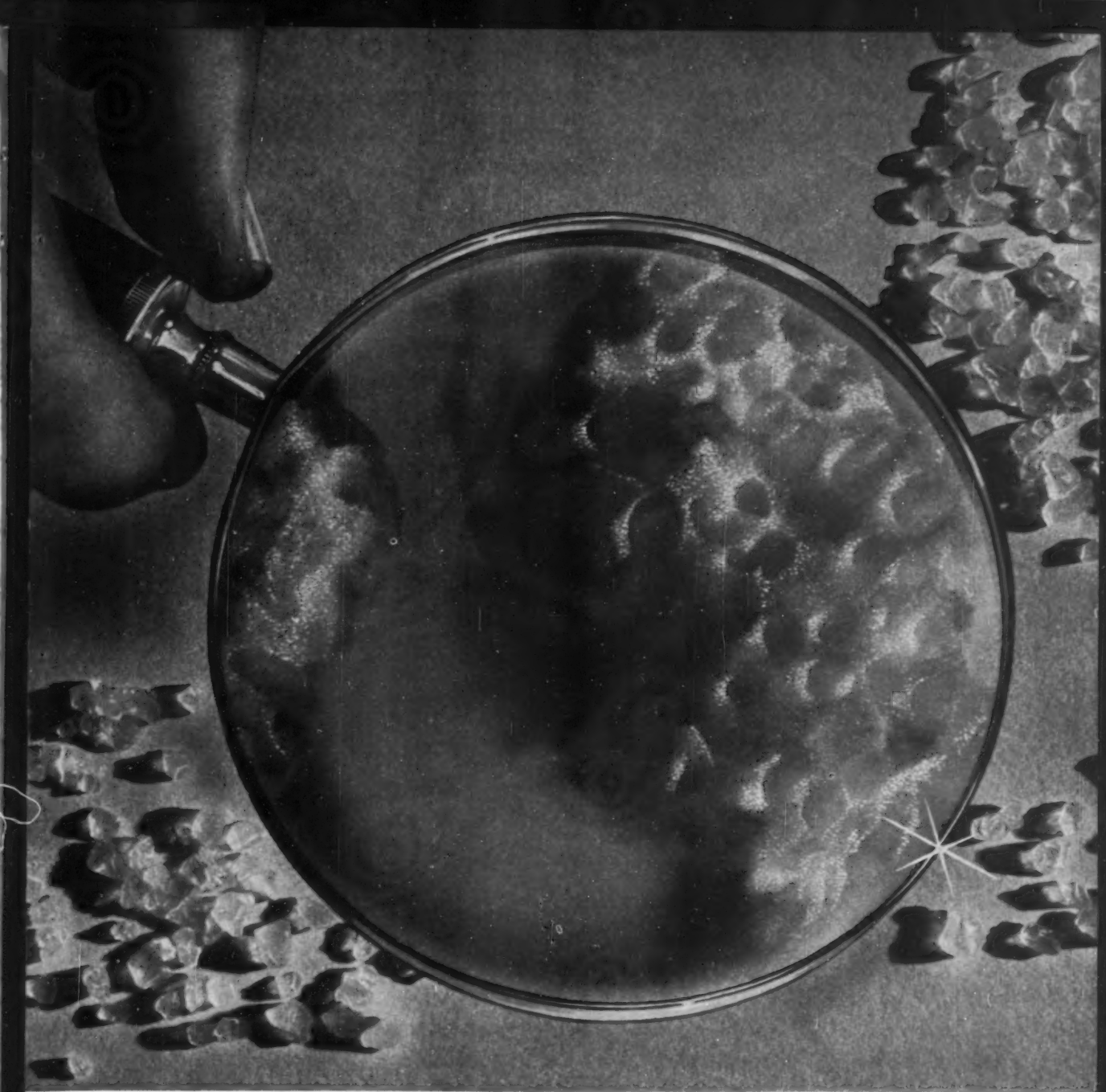
PETRECO

A DIVISION OF PETROLITE CORPORATION

3202 SO. WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 E. BURNETT STREET, LONG BEACH 7, CALIF.

Specialized Petroleum Treating Processes and Equipment—DESALTING • DEHYDRATING • DISTILLATE TREATING
SWEETENING • LUBE OIL TREATING • SEDIMENT REMOVAL

DT 58-4



Millions of tiny pores like these make Davison Silica Gel "vapor-thirsty"!

THEY STRONGLY ATTRACT CONDENSABLE VAPORS, HOLD THEM AS LIQUIDS

Is it any wonder that Davison Silica Gel is ideally suited for air and gas dehydration?

One cubic inch of this high capacity adsorbent and desiccant contains pores having a surface area of about 90,000 square feet (roughly the same surface area as the flight decks of two aircraft carriers). Davison Silica Gel can adsorb up to 40% of its weight of moisture at 100% relative humidity. Even when saturated, it remains dry and free flowing.

Davison Silica Gel is specially treated to give optimum resistance to attrition, and promotes rapid dehydration because of its granular shape. High purity (99.70% SiO_2) and chemical inertness contribute to its resistance to fouling.

A variety of particle sizes, densities and adsorptive capacities are available. Each has been developed to meet specific application demands. There is one to suit yours.

W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND

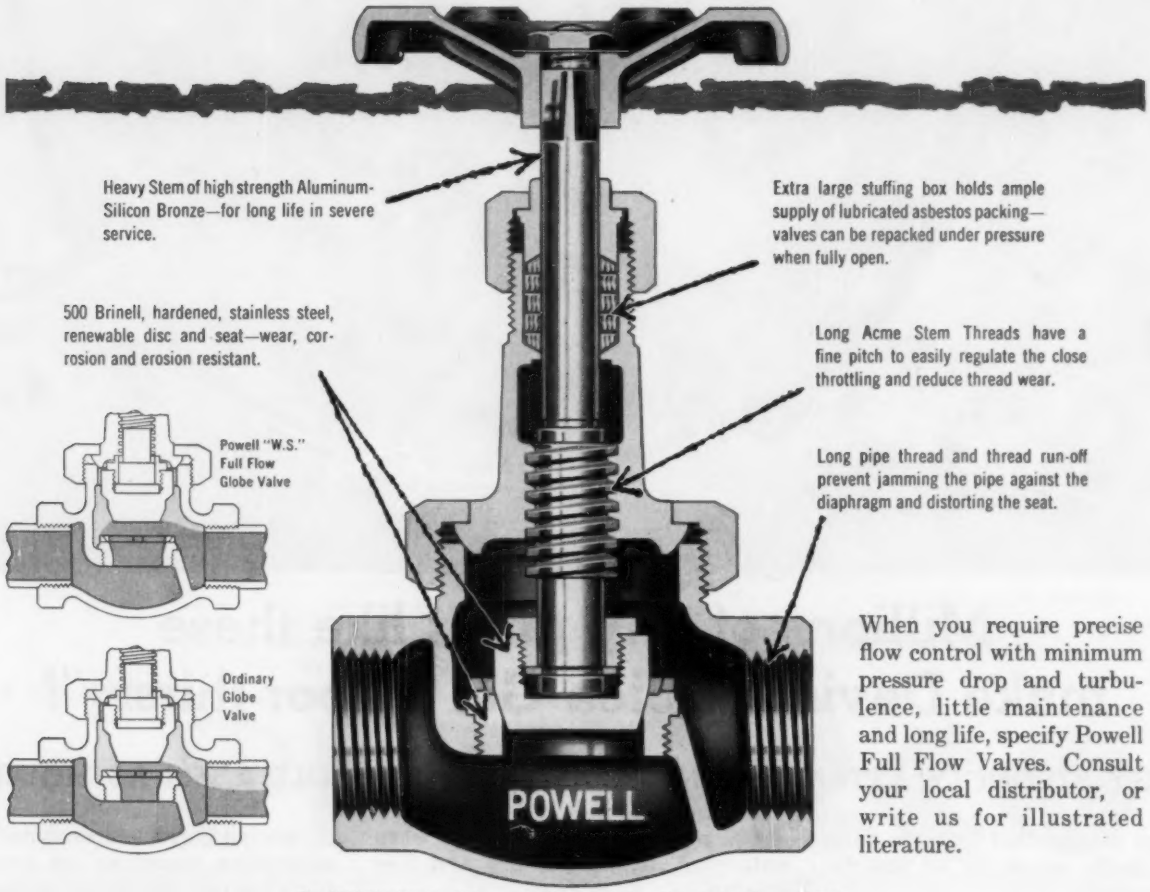
BULLETIN!

POWELL introduces new member in world's largest family of valves

Powell engineered "Full Flow" bronze valves are now available in a full line: the brand-new 150-pound screwed end Globe Valve, in addition to the well-known 200-300 pound Screwed and the 150-300 pound Flanged Globe and Angle Valves.

Although designed by Powell to assure maximum flow with minimum pressure drop and internal turbulence, these valves can be throttled to permit only the minutest amount of fluid to pass through. And, if desired, they can be supplied with Indicator Collar, Arm and V-port Disc for quickly determining flow and holding it constant.

Compare these advantages of Powell Full Flow valves:

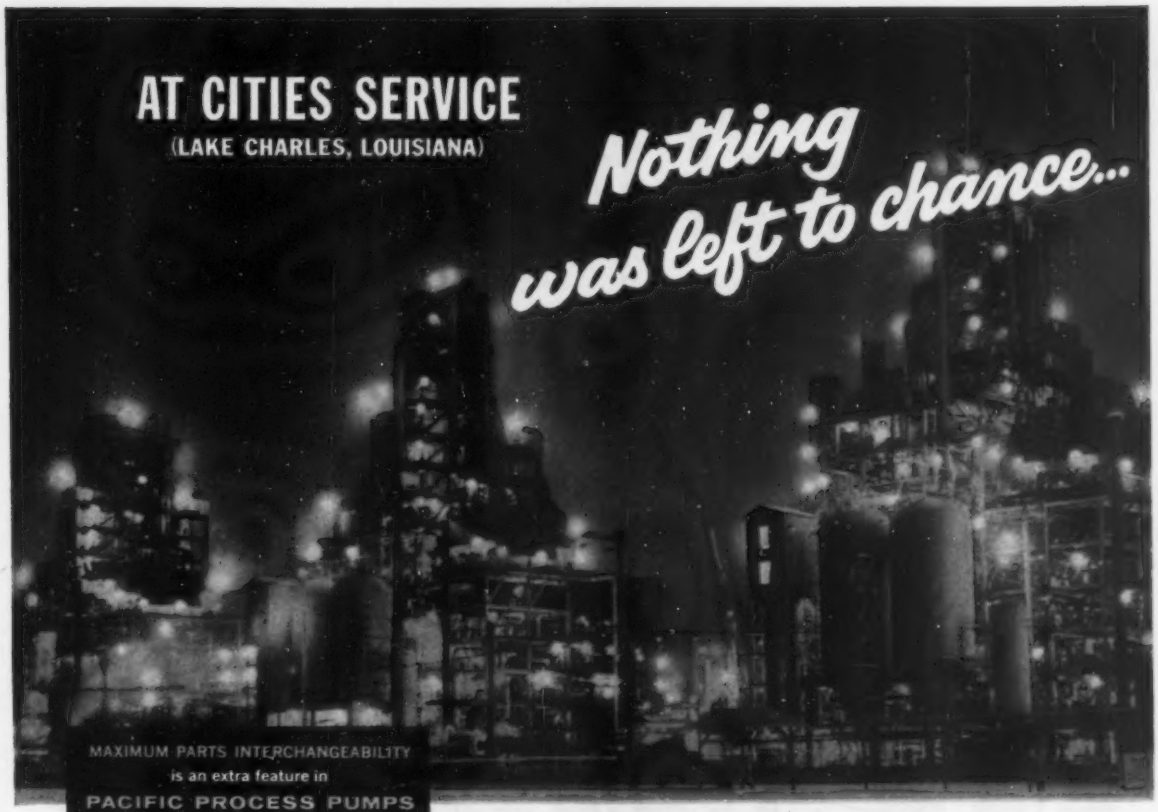

Heavy Stem of high strength Aluminum-Silicon Bronze—for long life in severe service.
Extra large stuffing box holds ample supply of lubricated asbestos packing—valves can be repacked under pressure when fully open.
500 Brinell, hardened, stainless steel, renewable disc and seat—wear, corrosion and erosion resistant.
Long Acme Stem Threads have a fine pitch to easily regulate the close throttling and reduce thread wear.
Long pipe thread and thread run-off prevent jamming the pipe against the diaphragm and distorting the seat.
Powell "W.S." Full Flow Globe Valve
Ordinary Globe Valve
POWELL

When you require precise flow control with minimum pressure drop and turbulence, little maintenance and long life, specify Powell Full Flow Valves. Consult your local distributor, or write us for illustrated literature.

Fig. 2600 (Sectional)—150-pound "W.S." Full Flow Globe Valve, Screwed Ends

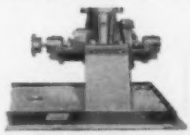
THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

For more data on advertised products, use Readers' Service Cards, last page.

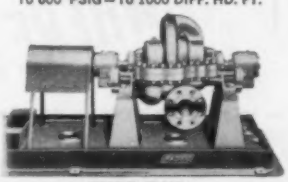


MAXIMUM PARTS INTERCHANGEABILITY
is an extra feature in
PACIFIC PROCESS PUMPS

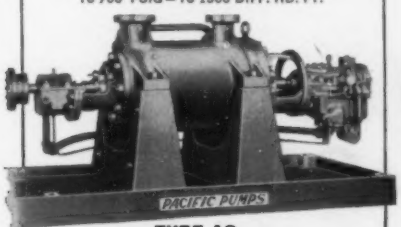
TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.



TYPE AC
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

PACIFIC PROCESS PUMPS *in service:*

CITIES SERVICE REFINERY	306
PETRO-CHEMICAL, INC.	138
CIT-CON, INC.	137
TOTAL	582

The three fluid catalytic crackers illustrated have established new records for continuous operation since going on stream. Under the most demanding service conditions, all three units came through remarkably. Number two unit operated for 1058 consecutive 24-hour days only to be outdone by its sister unit with a record of 1065 days continuous operation. We feel that the 100% Pacific installation (including slurry pumps) contributed to making these run-records possible.

Elsewhere throughout Cities Service, P.C.I. and Cit-Con operations, Pacific process pumps are delivering equally dependable 'round-the-clock service...convincing evidence that "nothing was left to chance."

Write for Complete Line Bulletin 1C plus individual bulletins for pumps illustrated in panel.

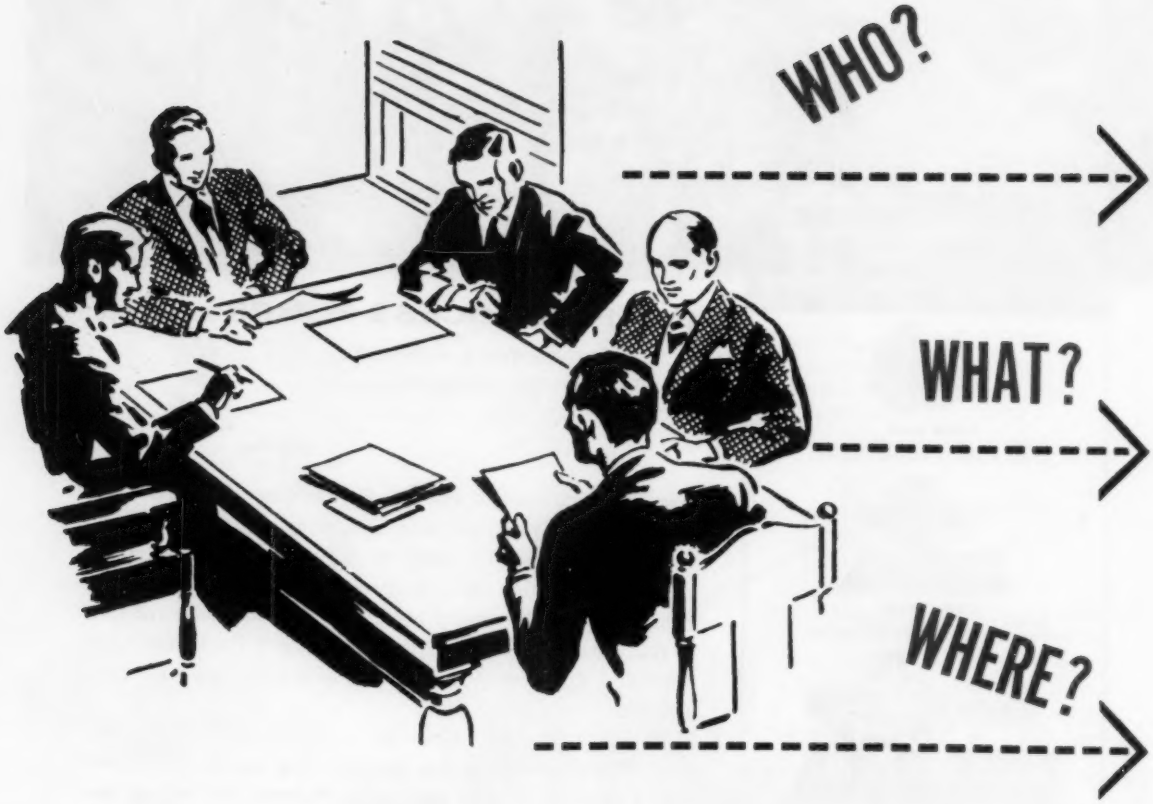
PACIFIC

PACIFIC PUMPS INC
A Division of Dresser Industries, Inc.
HUNTINGTON PARK, CALIFORNIA

CP-20

For more data on advertised products, use Readers' Service Cards, last page.

With Men

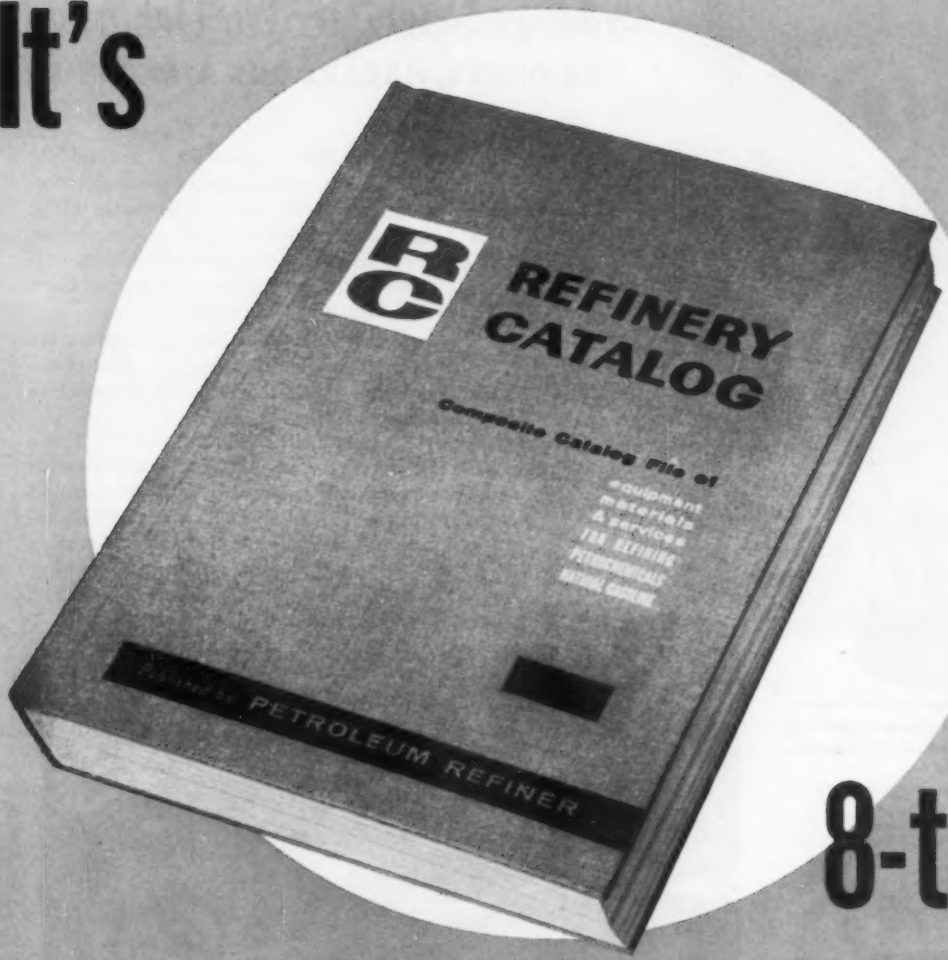


REFINERY CATALOG

Published by Petroleum Refiner

Who Buy And Specify

It's



8-to-1

Look to REFINERY CATALOG for quick answers to your procurement problems in the refining, natural gasoline and petrochemical industry. It's indexed and cross-referenced to save time and eliminate error in planning, buying and specifying for this fast-moving market. That's why buyers and specifiers express a preference of 8-to-1 for REFINERY CATALOG over individual product catalogs.

The next time *you* sit down to figure a job, look *first* in REFINERY CATALOG. You'll find it contributes to greater speed and accuracy.

Here's Why PETROLEUM MEN *specify...*

EC&M
OIL-BREAK STARTERS
(2200-4800 VOLTS)

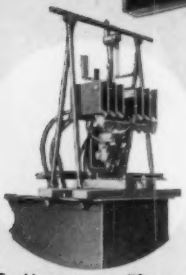
—THEY'RE *Specifically Designed* FOR DUSTY, HAZARDOUS ATMOSPHERES

Exterior and interior views of EC&M Type ZHS High Voltage Starter in NEMA 3R (raintight) enclosure with threaded connections for conduit

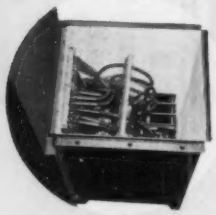
EC&M Type ZHS Starters are a "natural" for hazardous atmospheres because the high interrupting capacity ZHS contactor operates under oil. Being totally oil-immersed, this contactor is always well lubricated, protected from corrosion and requires infrequent inspection. There are additional advantages—

QUICKLY INSTALLED because starters are shipped with all internal wiring complete. These ready-to-use starters cut installation time and cost.

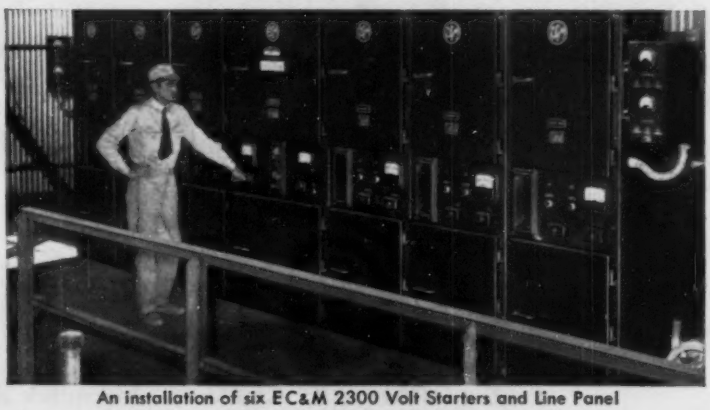
HIGH INTERRUPTING CAPACITY • These EC&M Starters are available in enclosures for indoor or outdoor mounting, and are supplied in 3 ratings—*(1)* 50,000 KVA (certified) interrupting capacity (inherent in the starter)—*(2)* with power-type, current-limiting fuses—*(3)* VALIMITOR® (volt-ampere-limitor), the bus may be of unlimited KVA.



With EC&M contactor-lifter, contactor is easily raised above oil level for easy inspection without disconnecting any bolts or leads



Down-view into oil tank. Note compactness of contactor and transformer assembly. All leads are anti-syphon



An installation of six EC&M 2300 Volt Starters and Line Panel for vertical deep-well pumps

EC&M also builds high interrupting capacity AIR-BREAK Starters

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

8586-R

Capacity Tripled

with only 30 days' downtime!

Kellogg Alkylation Unit Minimizes Gulf Revamp Costs

Economy-minded engineering by The M. W. Kellogg Company enabled Gulf Oil Corporation to minimize downtime and capital investment when increasing the capacity of Alkylation Unit No. 1 at its Port Arthur refinery.

Now producing 5,000 BPD of alkylate, this former 1,500 BPD unit was expanded primarily by installing two modern, five-section Kellogg Model B Cascade Reactors—shown at left. Other equipment added included pumps, exchangers, vessels, and instruments. By utilizing four original towers and much of the original equipment, costs were reduced considerably.

Despite the problem of integrating the existing equipment with the new, downtime between shutdown of the old unit and putting the expanded facilities on stream was only one month—an insignificant loss compared with savings in investment.

In this case, Gulf's own maintenance crew hooked up the new unit to the existing towers. Kellogg operators assisted in bringing the job on stream.

Kellogg welcomes the opportunity to work on your expansion or revamp projects. For prompt attention, write Kellogg's Contract Sales Division.

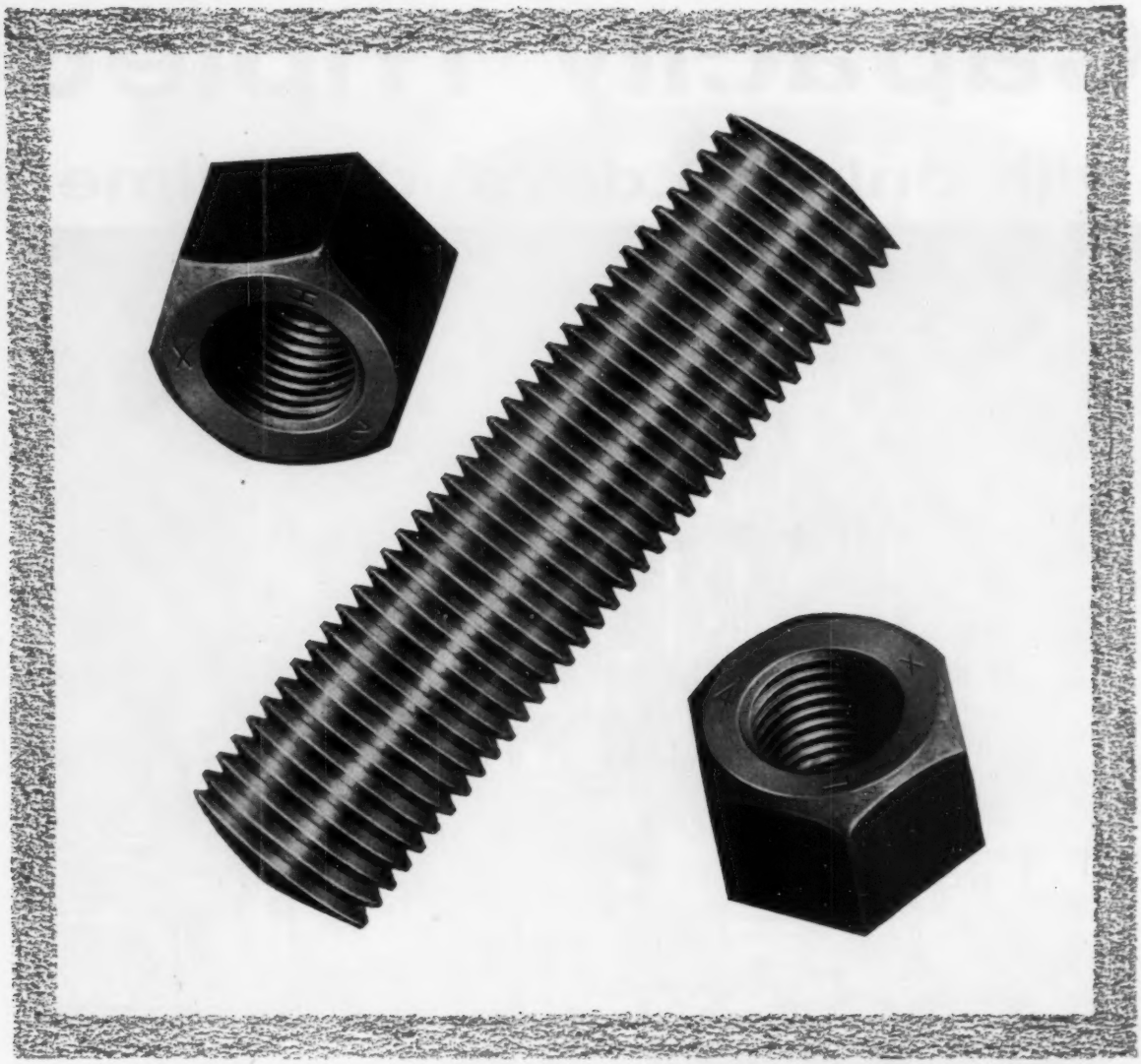
THE M. W. KELLOGG COMPANY

711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

For more data on advertised products, use Readers' Service Cards, last page.



The payoff comes at high temperatures

You can look for long service life when you use the Bethlehem Continuous-Thread Stud in refinery bolting. That's because it is engineered to resist both elevated temperatures and high pressures. Since the stud has no point of thread runout, it is impossible for stresses to concentrate at any given area. Instead, any stresses which might cause premature failure are more evenly distributed over the full working length of the stud.

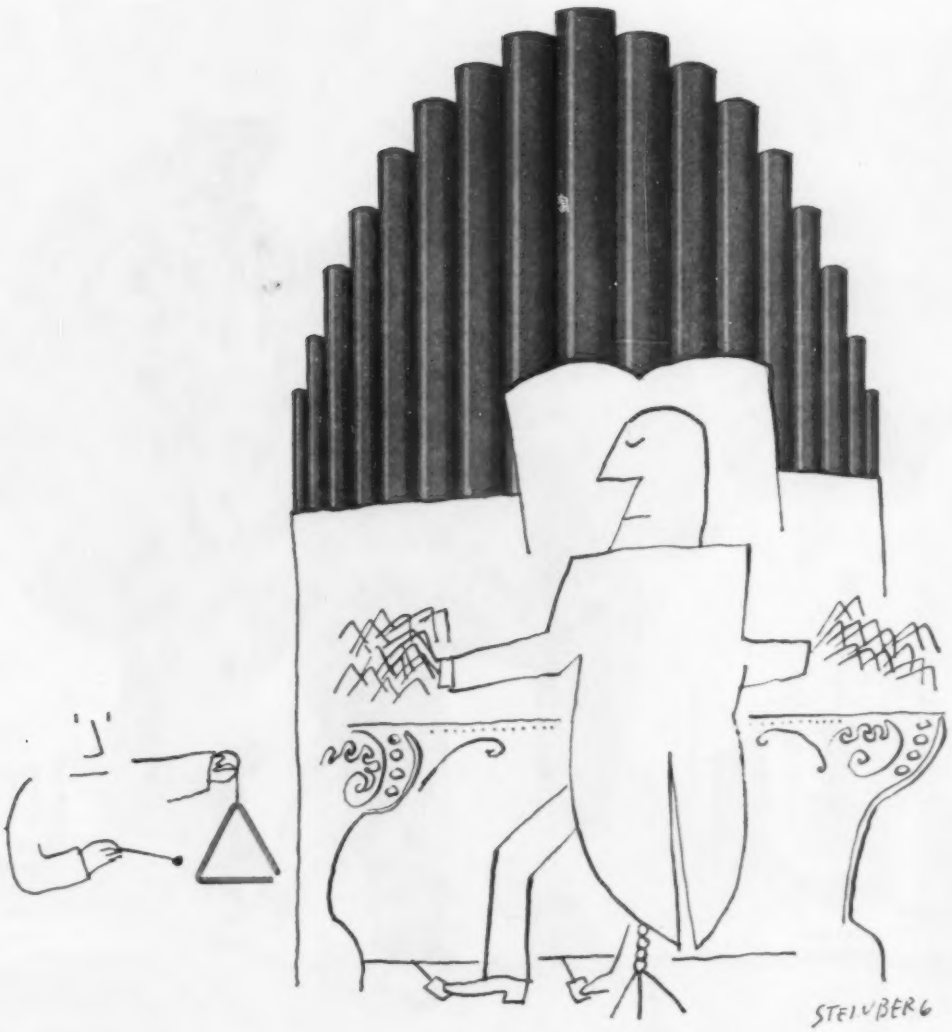
The Bethlehem Quenched Nut, used with the continuous-thread stud, is made from 0.40 to 0.50 carbon steel. In the larger sizes, the nut is formed by forging and extruding hot steel; it is then quenched and tempered before tapping. This gives the nut the strength to outperform practically any stud or bolt on which it may be applied.

For low cost bolting, use the Bethlehem Continuous-Thread Stud, with Quenched Nuts, in all of your high temperature installations. For full details, get in touch with the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL



high fidelity

Lewin-Mathes' quality strikes a responsive accord.

Despite the large number of new customers for Lewin-Mathes Copper and Brass tube, pipe and rod in recent years, better than 90 per cent of our business comes from *repeat* customers. High fidelity of a rare order!

So long as we remain faithful to the highest standards of tolerance, temper and uniformity, we can expect our customers to remain loyal to Lewin-Mathes products. And as specialists—with a *completely integrated* plant designed specifically for the manufacture of tube, pipe and rod—it's in our own best interest to be *perfectionists.*

For the most fitting accompaniment to your plumbing, heating and air conditioning installations, specify...

LEWIN MATHES

SAINT LOUIS, MISSOURI

COPPER AND BRASS TUBE, PIPE AND ROD

DIVISION OF CERRO DE PASCO CORP.

For more data on advertised products, use Readers' Service Cards, last page.

How Girdler experience in hydrogen plants can help you

Girdler has built much of America's hydrogen plant capacity installed during the past ten years. Big and small . . . for low-purity or for high-purity hydrogen . . . these plants provide undisputed evidence of Girdler's know-how and ability. So . . . to get top experience in hydrogen facilities and to assure utmost reliability of supply of hydrogen . . . call in Girdler when you start to plan.

GIRDLER CONSTRUCTION DIVISION
CHEMETRON CORPORATION
Louisville 1, Kentucky
Sales Offices: New York, N. Y.; San Francisco, Calif.

CHEMETRON
TRADE MARK

For more data on advertised products, use Readers' Service Cards, last page.

Photo taken at Delaware Refinery, Tidewater Oil Company

They keep the big cats roaring

The healthy roar of production from the big cat crackers is the measure of progress in refining and chemical technology. Teamwork between refiners and Cyanamid chemists helped to bring the development of one of the first synthetic fluid cracking catalysts and the first fully regenerative platinum reforming catalyst. Behind Cyanamid's service as a major catalyst producer are its unlimited resources as a major chemical producer.

Only Cyanamid's man with the golden rule can bring such vast chemical research and development facilities to the service of further refining progress.

Basic in Catalyst Chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, N. Y.

Originators of AEROCAT® Fluid Cracking Catalysts, AEROCAT TRIPLE A® High Alumina Catalysts, AEROCAT® 2000 Fluid Cracking Catalyst, AEROFORM® Fluid Hydroforming and Platinum Reforming Catalysts, AERO® HDS Catalysts, AERO® Specialty Catalysts, CYPAN® Drilling Mud Conditioner, AEROLUBE® Lubricating Oil Additives, AERONOX® Antioxidants, AEROSOL® Surface Active Agents

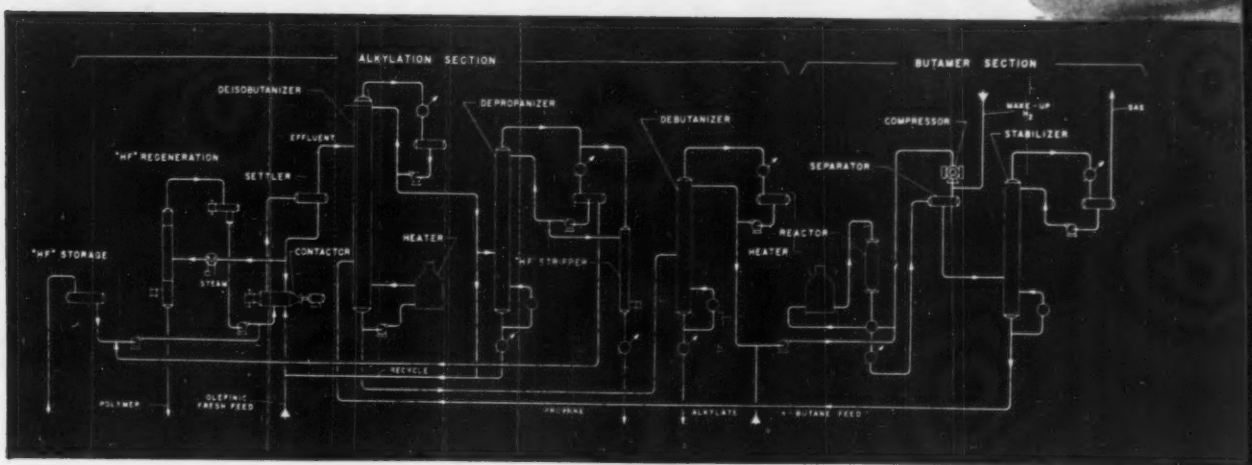
BUTAMER*

The most practical method for producing alkylate: Butamer and HF Alkylation in combination as a single unit

Increasing use of alkylate for blending into motor fuels makes these two up-to-the-minute processes highly important to petroleum refiners. Butamer is a new process for producing isobutane . . . "HF" Alkylation is an efficient, economical process which combines isobutane with olefins to produce alkylate, much in demand today as a motor fuel component.

With the advent of high compression ratio engines, usually starting at 9.5:1, motor fuel, especially those deficient in isoparaffins, have been associated with an unusual engine noise called "rumble." Further study reveals this rumble can be eliminated through the use of a better balanced fuel, namely using a fuel composed of a greater volume percentage of isoparaffins. Alkylation produces a high octane isoparaffin that also has good sensitivity, ignition point and combustion characteristics.

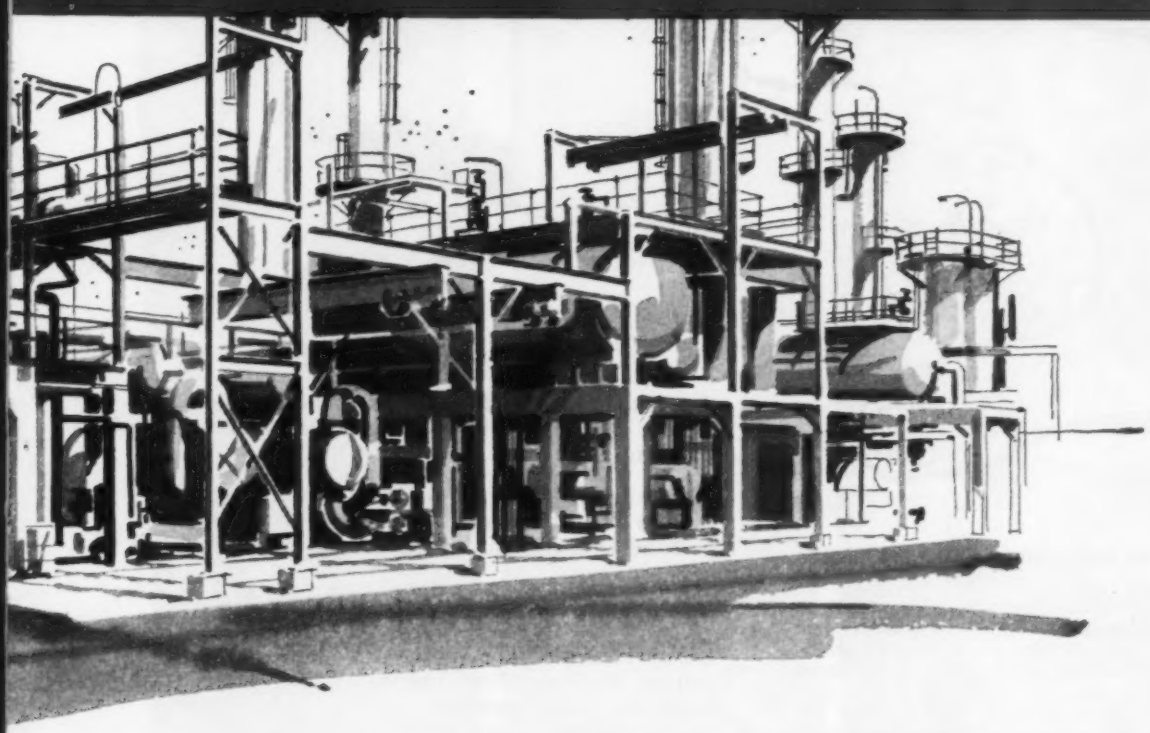
*Trademark



More Than Forty Years Of Leadership In Petroleum Refining Technology

For more data on advertised products, use Readers' Service Cards, last page.

HF Alkylation



Butamer—Heart of this process is a noncorrosive, stable and rugged platinum-containing catalyst especially developed by UOP. Capable of operating at relatively low temperatures, its use assures a sufficiently high concentration of isobutane in the reactor effluent to eliminate excessive recycle of normal butane.

Operating under hydrogen pressure, with low hydrogen-to-charge ratio, the high catalyst activity results in economical liquid hourly space velocities, thus requiring only a modest catalyst inventory. The mild operating conditions further assure minimum loss to by-products.

HF Alkylation—"HF" Alkylation is a catalytic process which combines olefins such as propylene, butylenes, and amylenes with isoparaffins (usually isobutane) to form a mixture of branched chain hydrocarbons of higher molecular weight known as alkylate for aviation and motor fuel.

These two processes are readily and economically integrated. Together, they form the ideal, most practical method for producing alkylate.

Write for detailed information. Ask also about other UOP refining and petrochemical processes, available to refiners everywhere, for improving operating efficiency and producing better and more profitable petroleum products.

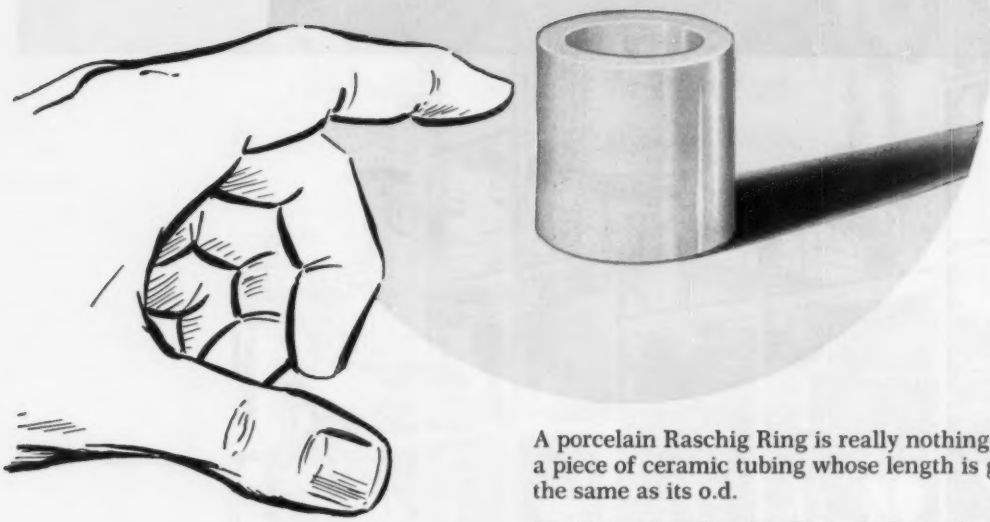
UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

What makes a good porcelain Raschig Ring?



A porcelain Raschig Ring is really nothing more than a piece of ceramic tubing whose length is generally the same as its o.d.

Most porcelain Raschig Rings look much alike. But there is a whale of a difference in the way they perform, and the way they stand up in service.

What makes a good porcelain Raschig Ring? And how can you tell?

Physical examination will tell you a lot. Check a number of pieces taken at random from a commercial shipment. (Hand picked samples can mislead you!) Are they uniformly round? Or is there a high percentage of oval rings? Flattened rings will reduce tower efficiency. Check wall thickness. Rings with extra heavy walls (a result of die wear) cut down on column free space, hurt tower performance.

Make comparative lab tests on porosity. Check weight loss from acid attack. Load bearing tests will indicate crushing strength. In making these checks you will be duplicating the routine tests we make on all ceramic rings of our manufacture.

How can you be sure of getting good porcelain Raschig Rings? There are many tests you can make to compare values. But the simplest way to be sure is to buy "U. S. Stoneware."

Do you have these Engineering Data?

As part of our continuing research, U. S. Stoneware makes available a wealth of data helpful to all engineers concerned with the design and operation of Packed Towers. With the exception of the 232 page book—"Tower Packings and Packed Tower Design"—the bulletins are free on request.

- ☐ Bulletin S29-R. Complete data on the performance of Intalox Saddle Packing.
- ☐ Bulletin TP-54. Data on all packings of our manufacture, including Raschig Rings and metal Pall Rings.
- ☐ Bulletin TA-30. How to select and install Support Plates and Distributors.
- ☐ Bulletin HDP-56. The use and function of Hold-down Plates.
- ☐ Tower Packings and Packed Tower Design. 232 page text book, written by Max Leva, and published by The U. S. Stoneware Co. It is available in a cloth binding for $8.50 per copy, and in a special paper bound edition for students at $3.50 per copy.

Address literature requests to
Engineering Dept.
The U. S. Stoneware Co.
Akron 9, Ohio

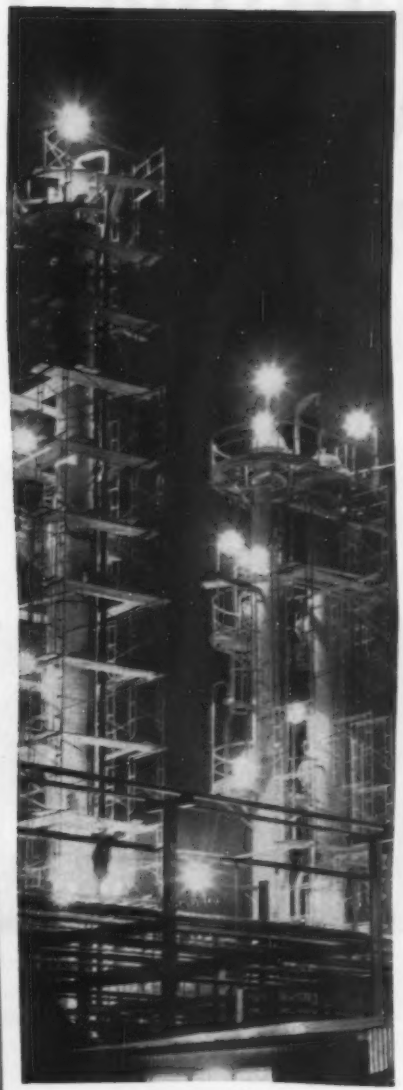
U. S. STONEWARE
AKRON 9, OHIO

133-F

For more data on advertised products, use Readers' Service Cards, last page.

Drastic reduction of heat loss with **PABCO PRECISION-MOLDED CALTEMP** a Calcium Silicate Insulation

When vapors or liquids are conveyed or held at temperatures up to 1900° F.—when equipment is operated to high heat levels – Pabco insulations cut heat losses to absolute minimums. "Precision-Molded" by a patented process, Pabco's Caltemp and 85% Magnesia pipe and block insulations control temperatures within close tolerances. For data on technical advantages, case histories, or engineering consultation, write...or call a Pabco insulation engineer.



INSULATION GUIDE

Temperature	Recommended Pabco Insulation		
to 550°	85% Magnesia pipe covering	block	cement
to 1200°	Caltemp pipe covering	block	cement
to 1500°	Prasco 15 C pipe covering	block	cement
to 1900°	Prasco 19 C	block	

PABCO

INDUSTRIAL INSULATIONS DIVISION

Fibreboard Paper Products Corporation

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For more data on advertised products, use Readers' Service Cards, last page.

POSITIVE, TIGHT VALVE CLOSURE...

under all variations of Temperatures and Pressures

* Simple indicator always shows amount of compensating spring compression.

New TYPE SA LimiTorque WITH COMPENSATING SPRINGS

Correct seating of the valve is extremely important during automatic valve operation, especially where fluctuation of high line temperatures are encountered.

To assure an absolutely tight seat, the new LimiTorque Type SA Unit incorporates unique compensatory springs which, literally, "take up" any amount of contraction or expansion caused by decreasing or rising line temperature.

These springs of Belleville Disc type vary in number for use in either parallel or series, within fixed limits, to provide the desired compensation. The result of continual improvement and development, the Type "SA" LimiTorque contains all the features of the famous Type SMA unit plus a simple indicator to show the amount of compensating spring compression. Available in Weatherproof and Explosion proof construction, these units can be mounted on any size valve in almost any position.

For information and data, write for Bulletin 4-57.

features:

- Controlled thrust applied to valve operating parts.
- Greater torque, thrust and stem capacity.
- Easier handwheel operation.
- Two piece stem nut design permits changing unit from one valve to another.
- Torque control for both directions of stem travel or single direction as required.
- Lubricant sealed in for life of unit.
- Simple indicator which always indicates amount of compensating spring compression.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

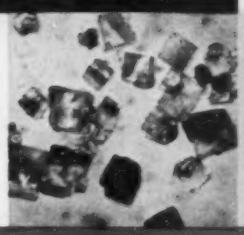
Limitorque Corporation • Philadelphia

FIRST *choice as chemical* AIDS *for these*

REFINERY PROBLEMS

TRETOLITE PRODUCTS

SALT



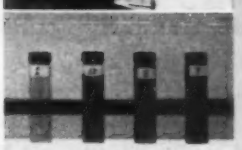
TRETOLITE* DESALTING. Performs in the 98% to 100% salt removal range. Prevents salts, solids, trace metals, other impurities from entering refinery stream; prevents salt plugging, fouling in condensers, exchangers, towers; reduces clean-outs.

CORROSION

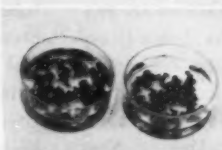
KONTOL* CORROSION INHIBITORS. Prevent internal corrosion, hydrogen blistering; help eliminate scaling, fouling. Adsorb to metal surfaces to form tough, impervious film. Powerful detergent action helps clean equipment.

PRODUCT DEGRADATION

KUPLEX* METAL DEACTIVATORS. Prevent hydrocarbon deterioration caused by metal-catalyzed oxidation. Deactivate harmful copper compounds which speed gum formation, sedimentation, color degradation.



TOLAD FUEL ADDITIVES. Stabilize domestic heating oils, diesel fuels. Inhibit sludge, disperse insoluble residue. Also improve color stability, prevent emulsification.



DEHYDRO* ASPHALT ADDITIVES. Cause surface of paving aggregates to become oil-wettable, insuring satisfactory coating in presence of free water. Help refiners meet all-weather asphalt specifications.

*TRADEMARK, REG. U. S. PAT. OFF.

TRETOLITE COMPANY

DIVISIONS OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri

5515 Telegraph Road, Los Angeles 22, California

Tretolite Refinery Service Engineers are always available to you for helpful consultation on your refinery problems. Just write, call or . . .

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Chemicals and Services for the Petroleum Industry

DEMULSIFICATION • DESALTING • CORROSION INHIBITING
PARAFFIN REMOVAL • SCALE PREVENTION • WATER DE-OILING • WATER FLOOD ADDITIVES • METAL DEACTIVATORS
ASPHALT ADDITIVES

AR-58-4

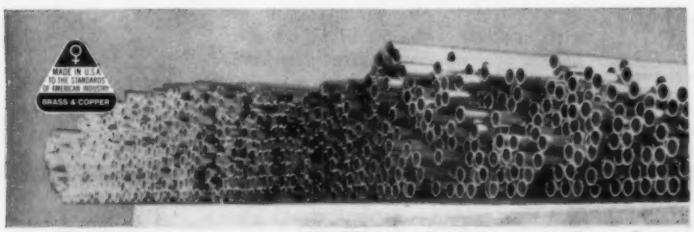
PROVED IN ACTION!

CHASE® HEAT EXCHANGER TUBES

High temperatures, "sour" corrosive crudes, additives and brackish water set up premature failure problems for heat exchanger tubes. That's why you'll find it pays to insist on Chase Antimonial Admiralty Tube...for retubing and in original equipment.

Chase Tube resists corrosion breakdown, withstands high temperatures and water-borne impurities. Good strength, excellent hardness, high thermal conductivity and resistance to fatigue, wear and abrasion assure you of longer service, less down-time, fewer costly replacements.

Field stocks are available in Tulsa (Vinson Supply Co.), Houston (Standard Brass & Mfg. Co.), Denver, New Orleans and Los Angeles. Mill stocks are always on hand in Cleveland, Ohio as well. If you need heat exchanger tube engineering service, just let us know. We'll be glad to send our special consultant to help you. For full details, talk to your nearest Chase District Office, or write Chase at Waterbury 20, Connecticut.



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Subsidiary of **Kennecott Copper Corporation**

The Nation's Headquarters for Brass, Copper and Stainless Steel

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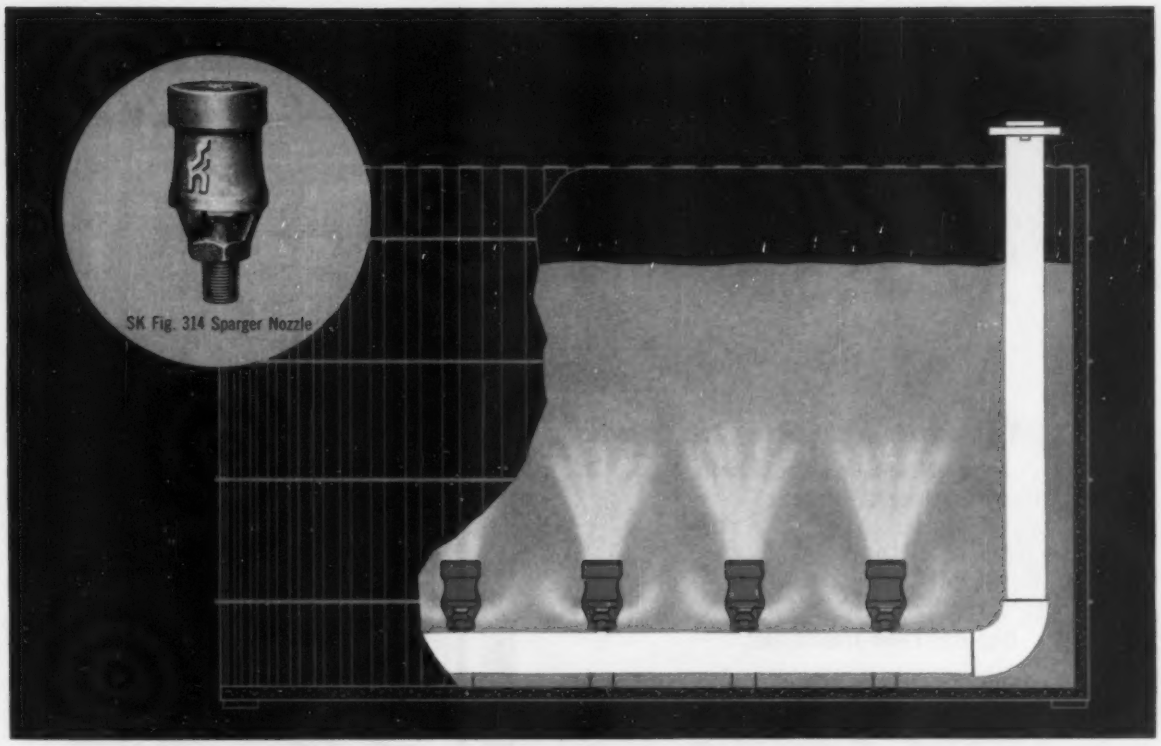
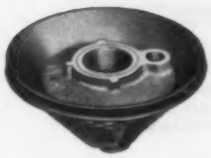
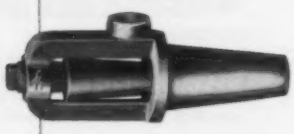


HOW TO HEAT AND AGITATE LIQUIDS IN TANKS

efficiently, economically, and with less noise



SK Fig. 301 Noiseless Heater for Tank Heating



SK Fig. 315 Circulating Heater for Tank Heating

SK Fig. 320 Continuous Heater for Pipe-Line Heating

SK Fig. 327 Slurry Heater for Pipe-Line Heating

Do it with plant steam and SK Steam Jet Heaters.

These Heaters utilize the jet principle to mix steam with a cold liquid, uniformly and without the noise and vibration usually associated with such operations. Since all of the heat in the steam is absorbed by the tank liquid being heated, operation is efficient. Because the jet action of the Heaters produces agitation and circulation, you need no additional equipment to perform these functions. Furthermore, since Steam Jet Heaters have no moving parts (except an adjusting spindle on some pipe-line types), you get long, trouble-free service without costly supervision and maintenance.

The illustration above shows tank heating being accomplished using SK Sparger Nozzles—one of the several types of Heaters offered by SK. Units of this type are ideal for use where uniform agitation is required over a large shallow tank area. In operation, a jet of steam issuing through the nozzle entrains tank liquid through the suction opening. Condensation takes place immediately upon mixing of liquid and steam and the stream of heated liquid is discharged at considerable velocity providing constant agitation.

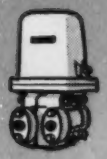
Several other types of SK Steam Jet Heaters—for both tank and pipe-line heating—are shown at left. Complete details on all types are contained in Bulletin 3A which is available on request.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2217 State Road, Cornwells Heights, Bucks County, Pa.

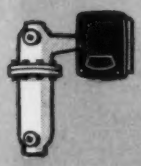
For more data on advertised products, use Readers' Service Cards, last page.

Indicating Motion-Balance Transmitters
...for flow, pressure, and level



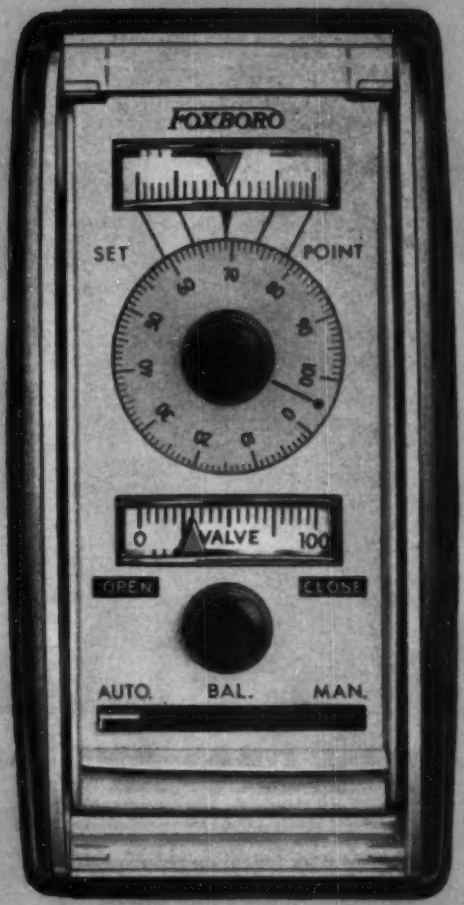
Low Displacement Force-Balance Transmitters
...for flow, pressure, and level

Thermocouple and Resistance Bulb Converters
...magnetic amplifiers...no vibrators
...no mechanical rebalancing



Displacer Level Transmitters
...force-balance for simplicity

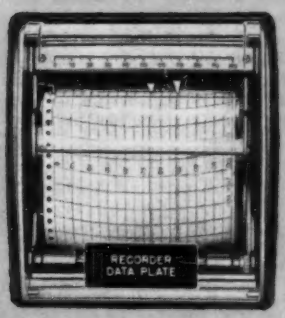
Control Valves
...electro-pneumatic and electro-hydraulic actuators



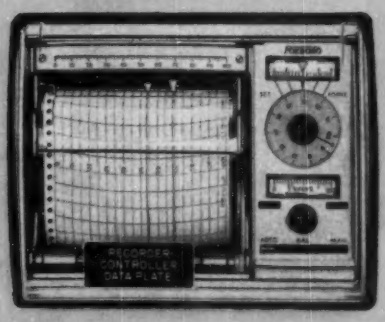
CONTROLLER
The Electronic Consotrol Controller (shown 4/5 actual size) concentrates all control and supervisory functions in one slim 3 x 6 inch case. Controller operation is entirely independent of recorder.

FOXBORO Electronic

REG. U.S. PAT. OFF.



RECORDER
Electronic Consotrol Recorders (shown ¼ actual size) use a simple, powerful pen motor which can be operated directly from transmitter signal without amplification. Available in 1 and 2 pen models.



COMBINED RECORDER-CONTROLLER
Electronic Consotrol housing design permits unequalled flexibility in panel arrangement. Recorders and controllers can be mounted separately in individual housings—or enclosed in a compound unit. Regardless of mounting, either unit pulls out independently.

for the first time... the 100% solid state electronic system!

- thermocouple and resistance bulb converters – using magnetic amplifiers
- choice of force-balance and motion-balance transmitters
- long time-constant tubeless controllers

Consotrol Instrumentation

Electronic Consotrol* Instrumentation—the most complete and advanced family of electronic-operated measurement and control instruments available today! That just begins to describe Foxboro's dramatic new advance in instrumentation. ✓ ✓ ✓ Foxboro electronic transmitters, indicators, recorders, control stations, computing stations, valve actuators and other final operators cover every function in the control loop. All are linked by a d.c. current signal. All are completely tubeless. Even thermocouple and resistance-type systems no longer require vacuum tubes. ✓ ✓ ✓ Electronic Consotrol systems convert temperature, pressure, flow, level measurement, etc., to a proportional signal **at the transmitter.** Transmission to a remote control station is instantaneous—using an electronic motion-balance or force-balance transmitter. Designs are available for both hazardous and non-hazardous areas. ✓ ✓ ✓ Electronic Consotrol Instrumentation heralds a whole new era in process control engineering. Write Foxboro today for the new 32-page Catalog 21-10 which gives full details. The Foxboro Company, 7410 Neponset Ave., Foxboro, Mass., U.S.A. *Reg. U.S. Pat. Off.

High-Strength Bonded Clad Material Described in New CB&I Bulletin

Hortonclad is a corrosion-resistant composite metal having an integral and continuous bond of exceptionally high strength produced by a special high-vacuum bonding process. Available only in CB&I-fabricated tanks, pressure vessels and other clad structures, Hortonclad provides uniform thickness because cladding and backing plate are both in their final thickness prior to bonding.

The Hortonclad process employs silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other metals and alloys.

Write our nearest office for a copy of the CB&I bulletin which describes these benefits of HORTONCLAD:

Two crude columns (left) and vacuum column (right) were partially clad using Monel Hortonclad and stainless steel. Crude columns are 174-ft. high. Vacuum column is 28-ft. in dia. at widest point and 125-ft. high.

P71-C

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PA. and at NEW CASTLE, DELAWARE.
In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO
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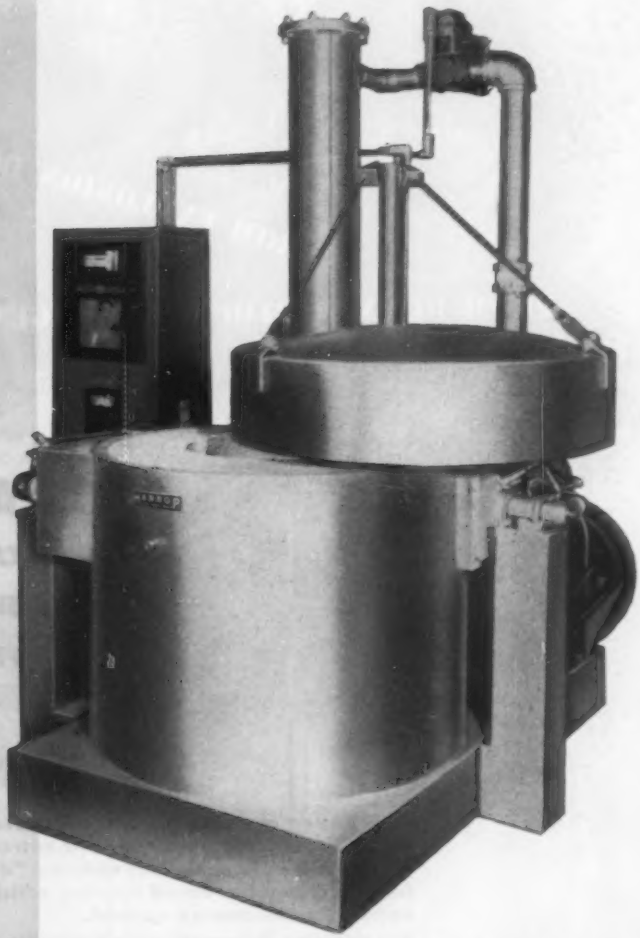
CB&I

New Protection For YOUR Equipment— At Temperatures Up To 3300°F

ALUNDUM castables offer unusual advantages to all industries using high temperature installations*



Will fire continuously up to 3300°F. This Harrop gas-fired furnace, recently developed by the Electric Furnace Division of the Harrop Ceramic Service Company, Columbus, Ohio, is particularly applicable to the firing of ceramic oxide bodies. Norton ALUNDUM 33-I Insulating Castable selected for the inner lining of the furnace and its roof, provided completely satisfactory protection under repeated tests at highest operating temperatures.

The new Norton ALUNDUM Castables are made in two types: 33-I Insulating and 33-HD Heavy Duty. At temperatures up to 3300°F both types have been extremely successful in protecting high temperature processing — in many industries and many different installations.

ALUNDUM 33-I Insulating Castable is made up primarily of pure aluminum oxide bubbles, tiny and countless. Forming a network of air spaces, it assures excellent insulation, even at highest commercial temperatures.

ALUNDUM 33-HD Heavy Duty Castable is chiefly composed of dense grains of pure aluminum oxide. It is recommended for forming dense monolithic surfaces in many types of furnaces where high temperature conditions are particularly severe.

Both 33-I and 33-HD Castables are very easy to store, mix and use. With them you can cast simple or complex shapes quickly and economically, replace more expensive pre-fired shapes, and cut maintenance and replacement costs to very lowest. Ask your Norton Representative for details, and for the folder *Two Norton Castables.* Or write to NORTON COMPANY, Refractories Division, 470 New Bond Street, Worcester 6, Massachusetts.

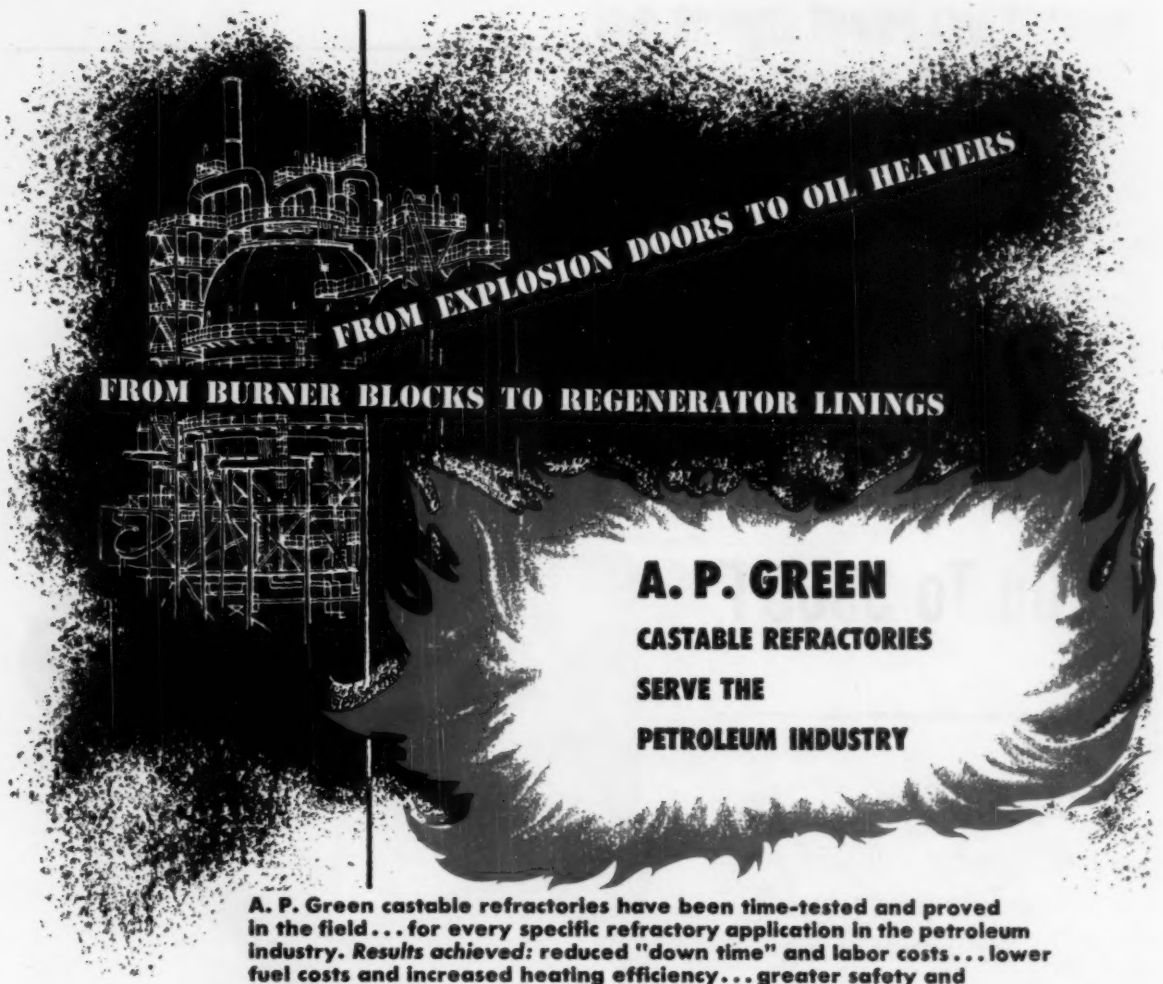
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEAR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.



A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.

For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

KAST-SET — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

KAST-O-LITE — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

CASTABLE INSULATION NO. 20 — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

CASTABLE BLOCK MIX — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

CASTABLES FOR GUN APPLICATION . . . SK-7 — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

KS-4 — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY

Mexico, Missouri, U.S.A.

Plants: Mexico, Mo. — Woodbridge, N. J. — Sulphur Springs, Texas — Jackson, Oak Hill, South Webster, Ohio — Philadelphia, Pa. — Troy, Idaho — Pueblo, Colo. — Macon, Ga.

IN CANADA: **A. P. GREEN FIRE BRICK COMPANY, LTD.**
Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

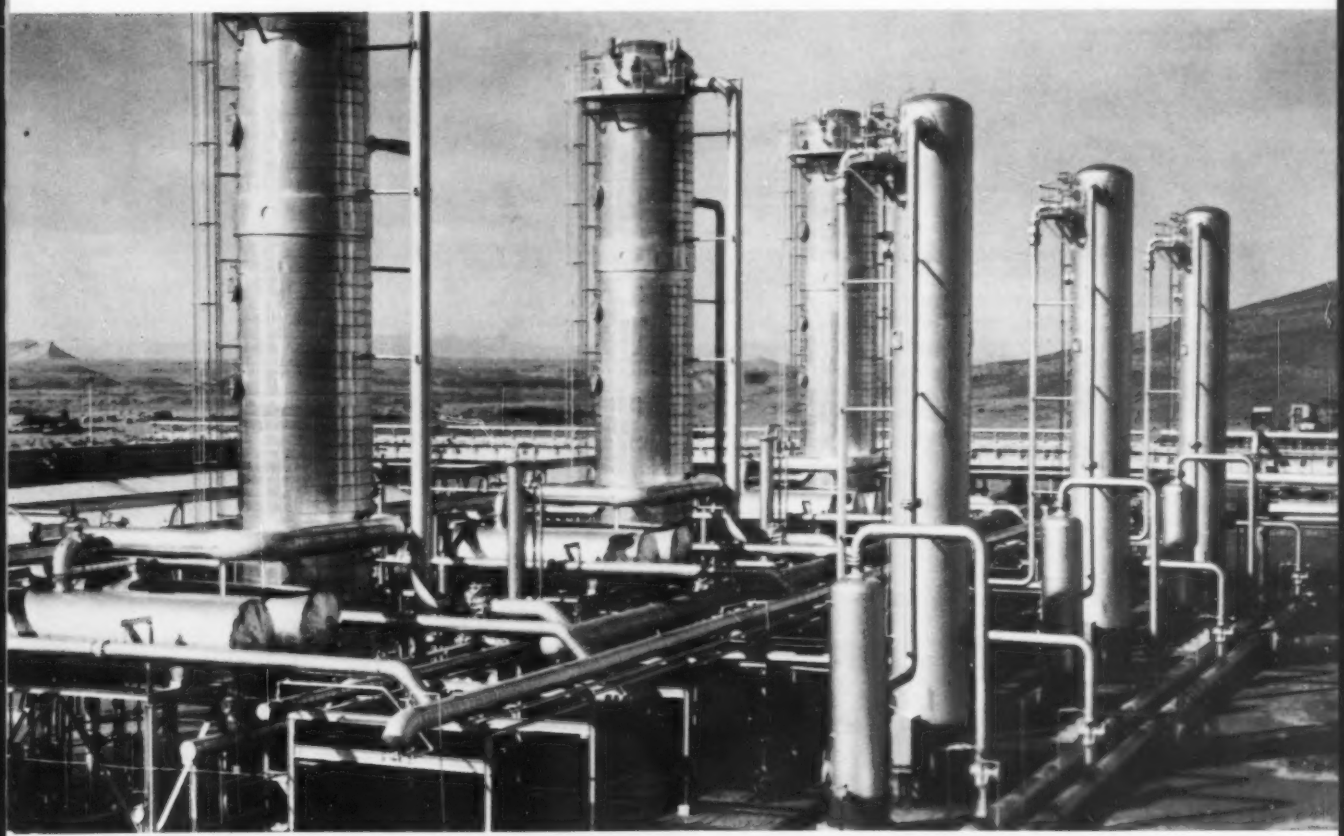
SPECIFICATION:

Process Equipment; Plant Structures; Transfer and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion

The one best answer to the process industries' problem of skyrocketing plant and equipment costs is to reduce corrosion damage. Fortunately there is a performance-proved way to do just that: specify Alcoa® Aluminum and ensure *corrosion-resistant* process equipment, transfer and storage equipment and plant structures.

No other metal matches the ability of aluminum to resist corrosive attack in so many operating environments. Happily, aluminum is usually the *least costly* metal able to serve satisfactorily in such situations. And aluminum, alone, provides the complete combination of important service benefits listed at the right.

Light Weight • Great Strength in Alloys • Good Workability • High Thermal and Electrical Conductivity • Nontoxicity • Good Reflectivity • Nonmagnetic, Nonsparking Characteristics • Clean, Attractive Appearance • Low Cost



On the following pages, you will find some of the many applications in which Alcoa Aluminum is daily being used to win the fight against corrosion in the process industries. Among them, you are sure to find ways in which *you, too,* can win this important battle.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

SPECIFICATION: *Process Equipment; Plant Structures; Transfer*

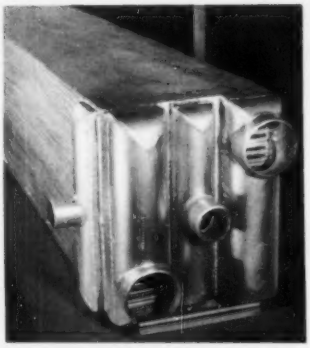
HEAT EXCHANGER TUBES

Low cost aluminum heat exchanger tubes combine initial equipment economies with freedom from chemical attack. Easy to fabricate, they have excellent thermal conductivity and are not subject to embrittlement at low temperatures.

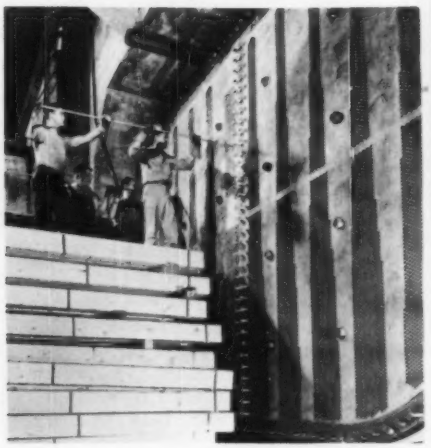
Aluminum tubes have thoroughly demonstrated their ability to give long-lasting, dependable service in severe operating conditions. They have been used extensively in exchangers handling hydrogen peroxide, nitric acid, hydrogen sulfide, naval stores, glycerine, ammonia, hydrocarbons, steam acrylonitrile and many other chemicals. Alclad tubes are recommended for use with natural cooling waters.

Remember, too, that aluminum costs far less . . . ½ the cost of admiralty, less than 1/5 the cost of stainless, and even less than mild steel in common ¾″ and 1″ sizes.

Write for booklet AD186 containing detailed information on heat exchanger tubes of Alcoa Aluminum.



This brazed aluminum assembly, weighing nearly 900 pounds, is typical of exchangers used in air separation plants and other low-temperature exchange processes.



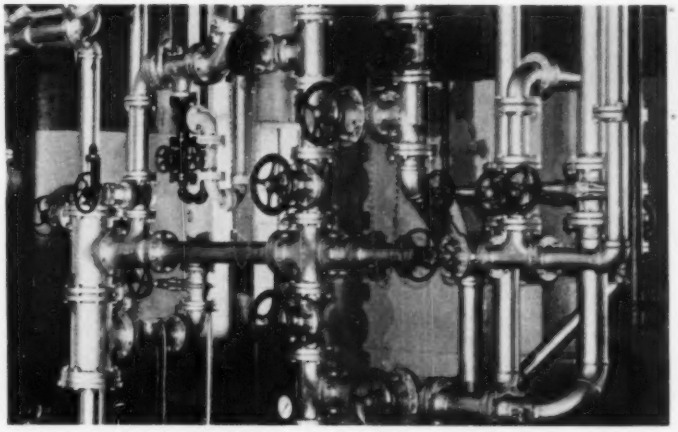
A 105,000 sq ft surface condenser with Alcoa aluminum heat exchanger tubes.

PROCESS PIPING

You get two-fold protection when you specify Alcoa Aluminum Pipe to carry liquids or gases in chemical, petrochemical, petroleum and food plants. It resists attack from the materials it carries as well as from corrosive atmospheres surrounding it. Naturally, the use of aluminum pipe will not introduce unwanted product contamination or discoloration.

Available in all normally produced schedules, Alcoa Aluminum Pipe is easily the lowest priced corrosion-resistant pipe available. For example, Schedule 40 aluminum pipe is ¼ the cost of Schedule 5 stainless and only 1/7 the cost of Schedule 40 stainless.

For more information, Send for booklet AD197, *Aluminum Pipe and Fittings*.

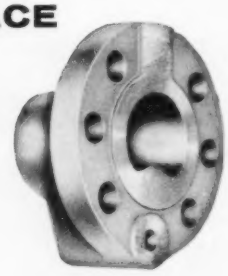


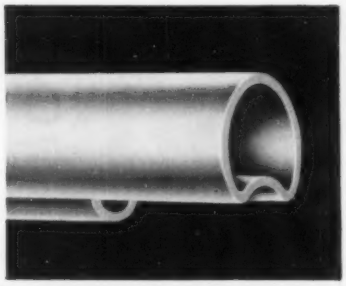
Alcoa aluminum pipe proved ideal to solve corrosion and product contamination problems in this processing plant.

UNITRACE

Only Alcoa makes available a complete line of components designed for Unitrace® which are compatible with conventional piping. With the recent addition of flange, Trace Cap, reducers and elbow fittings to the Unitrace line, it is now possible to design and install complete, fully integrated Unitrace steam-traced piping systems. Unitrace is the revolutionary steam-traced pipe of Alcoa Aluminum. Unitrace incorporates steam and product passages extruded in a single unit of aluminum alloy. It is available in diameters equal to 1½″, 2″, 3″, 4″ and 6″ pipe.

Get complete information on low cost, highly efficient Unitrace components. Write for Bulletin AD418.





New type Unitrace section showing trace line cut back for joint. (Right) Special cast Unitrace flange for easy, efficient joining of new type Unitrace sections.

ALUMINUM COMPANY OF AMERICA

Alcoa Building, Pittsburgh 19, Pennsylvania

and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion

Alcoa Standard Tanks provide storage economies for a wide variety of chemicals.

STANDARD AND SPECIAL STORAGE TANKS

Alcoa Standard Storage Tanks are fabricated from 3003 alloy and are available in both horizontal and vertical types in sizes ranging from 5,800 to 21,400 gallons. Because they are made with stocked components, they bring the user all the advantages of light, strong, corrosion-resistant Alcoa Aluminum at lower cost—with fast delivery.

Special storage tanks made of Alcoa sheet and plate can be constructed to meet specific requirements. Design and fabrication data will be furnished on request.

When you write, ask for Bulletin AD387, *Alcoa Standard Storage Tanks.*

World's largest all-aluminum tank stands 26 ft high, has a diameter of 128 ft, holds 2½ million gallons of 83% ammonium nitrate solution.

SHIPPING CONTAINERS

A wide variety of shipping containers conforming to ICC regulations is available from Alcoa. They range in size from 7½ to 110 gallons and are used to ship products ranging from beer to fuming nitric acid.

Lighter in weight than containers of other materials, Alcoa Aluminum containers are less expensive and give substantially longer service.

Aluminum exterior surfaces for buildings and conveyors provide pleasing appearance with minimum maintenance.

ROOFING, SIDING, STRUCTURALS & PAINT

Alcoa Industrial Building Products require practically no maintenance and serve well even when exposed to the corrosive atmospheres often encountered around processing areas. That explains the growing use of aluminum roofing and siding on plant buildings and outdoor equipment. Easily installed, it helps to keep construction costs low.

Alcoa also supplies structural shapes for use in construction where corrosion resistance and consequent low maintenance cost are advantageous.

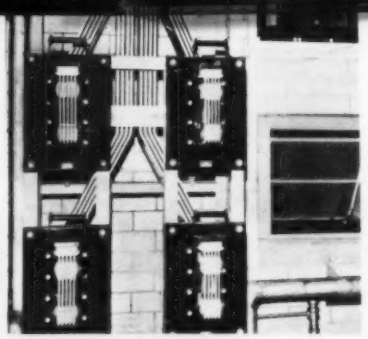
Paints pigmented with Alcoa Aluminum provide a continuous metallic sheet of pure aluminum for unmatched protective power. Where both color and protection are desired, Alcoa supplies nonleafing pigments to paint formulators.

Write for *Alcoa Industrial Building Products* booklet, AD285, *Alcoa Sandwich Walls* booklet, AD625, or *Painting with Aluminum* booklet, AD228.

ALUMINUM COMPANY OF AMERICA

Alcoa Building, Pittsburgh 19, Pennsylvania

SPECIFICATION: *Process Equipment; Plant Structures; Transfer and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion*



BUS BARS

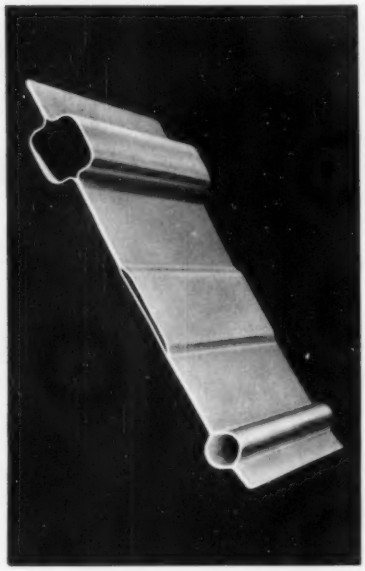
Excellent corrosion resistance, added to lowest cost per unit of current carrying capacity, makes aluminum ideal for bus bar use in process plants. Get complete information by writing for the Alcoa Bus Conductor Handbook, AD661.

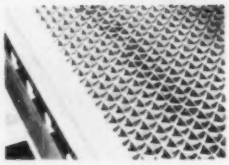
NEW ALCOA EXPANDABLE TUBE-IN-SHEET

Here's a brand new way to bring the outstanding corrosion resistance of Alcoa Aluminum to heat transfer operations. It's Alcoa Expandable Tube-in-Sheet. To produce it, Alcoa has perfected and greatly amplified a revolutionary process for creating tubular shapes as an integral part of aluminum sheet and plate.

These unique, one-piece units of aluminum sheet or plate contain a series of lengthwise, parallel areas that can be expanded hydraulically or with air to form integral tubes in a variety of shapes. Without complicated joining or fabricating, the product is ideally suited to solving heating and cooling problems found in many industrial processes.

Expandable Tube Sheet is available in all nonheat-treatable alloys and in heat-treatable alloys 6061, 2024 and 7075. It is shipped unexpanded in mill finish coiled or flat sheet. Get full information today.





GRATING, STAIR TREADS AND TREAD PLATE

Corrosion-resistant grating-type Alcoa Aluminum stair treads need no paint. They are available in all standard sizes at a price competitive with galvanized steel with abrasive nosing. (Write for Bulletin AD679.)

Aluminum grating is used widely for floors and walkways in and around processing plants because of its light weight, resistance to corrosion, low maintenance and nonsparking characteristics.

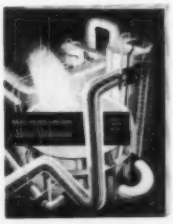
Alcoa supplies both a standard aluminum tread plate and Alcoa Abrasive Tread Plate. The latter has a self-renewing, bonded abrasive surface for extra nonskid protection. Write for Bulletin AD596.

ALCOA ENGINEERS WILL HELP YOU WIN THE FIGHT AGAINST CORROSION!

For over 40 years, Alcoa has worked with all segments of the process industries to develop a tremendous variety of applications in which aluminum can be used successfully to resist corrosion. That effort has resulted in an immense fund of practical nonconfidential information covering corrosion characteristics of many materials and processes under a variety of conditions. You can obtain this information without cost or obligation simply by writing Alcoa at the address given below.

When writing, state your requirements as specifically as possible . . . so that Alcoa's development engineers may supply you with the best data.

Write today! Join the thousands who have found Alcoa Aluminum their most important ally in the constant battle against the high cost of corrosion in the process industries.



THIS FREE BOOK

contains 80 pages of detailed data on the performance of aluminum in hundreds of applications throughout the process industries. It provides exact information on the behavior of aluminum with specific materials . . . along with complete design and specification information. Use it as your guide to the proper use of corrosion-resistant aluminum in your plants and equipment. When you write, ask for *Process Industries* Book, AD460.

Aluminum Company of America
905-K Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature (see above for booklet nos.):

_____

_____

_____

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

ALCOA THEATRE
Fine Entertainment
ALTERNATE MONDAY EVENINGS

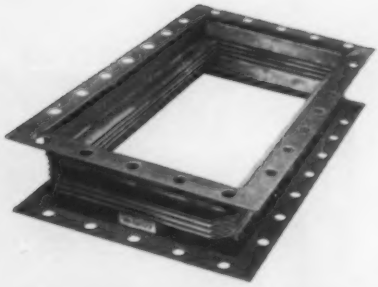
Name _____

Company _____ Title _____

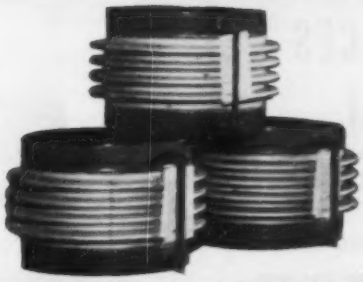
Address _____

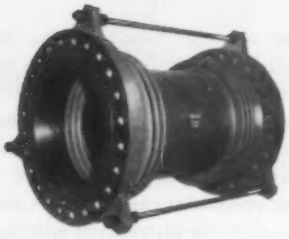
City _____ Zone _____ State _____

Form 68-11118

Solar builds 

the world's largest

array of  industrial

expansion joints 

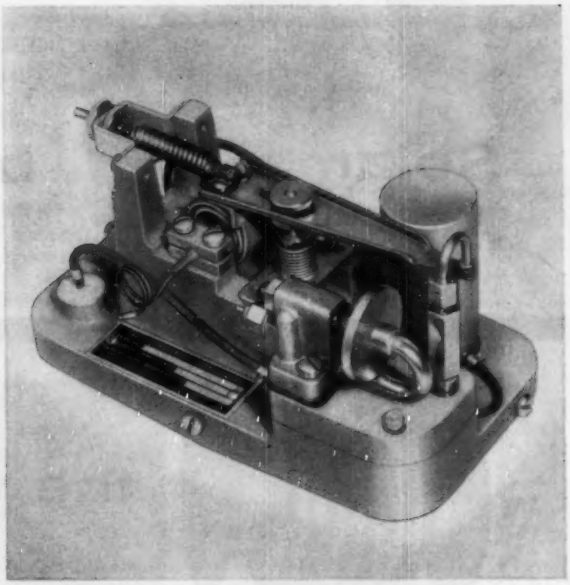
SOLA-FLEX® EXPANSION JOINTS are made from a wide variety of stainless and high alloys for important nuclear, missile and industrial applications. Sizes range from ½ in. to 35 ft in diameter. They are built for service from –320F to 1200F. And they tame "hard-to-handle" pressures up to 3500 psi for special applications.

Hot or cold, large or small, high pressure or low—no matter what your particular piping need, Solar can deliver exactly the right expansion joint for you. Best of all, rugged Sola-Flex joints can be "in service" in one to four weeks... *or less!* For a new Sola-Flex catalog, write to Dept. F-73, Solar Aircraft Company, San Diego 12, California.

SOLAR AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

For more data on advertised products, use Readers' Service Cards, last page.

LOW COST AND EASE OF INSTALLATION PERMIT WIDE USAGE.



OPERATIONAL SIMPLICITY IN A RUGGED, COMPACT UNIT.

TAYLOR ANNOUNCES NEW LOW-COST TEMPERATURE TRANSMISSION

New SENSAIRE* Transmitter: rugged, compact, force-balance, with mercury-filled system. Self-compensating for ambient temperatures.

The new Taylor SENSAIRE temperature transmitter now makes more widely available low cost temperature measurement within limits of minus 30°F. to plus 1200°F., with simplified adjustments and excellent repeatability. Available in range spans of 50°F., 100°F., 200°F., and 400°F.

Individual transmitters are factory calibrated in one of four available range spans. A simple thumb-screw adjustment zero-sets the instrument within wide limits. This adjustment is accomplished with high accuracy, and no further calibration is necessary. Factory calibrated accuracy is well within 1% of rated range, below 550°F; 1½ % above 550°F.

All SENSAIRE transmitters and components are interchangeable (regardless of range). A measuring system encompassing a new range span or new range limits (other than those obtainable with zero adjustment) may be added in the field.

Write for SENSAIRE **Bulletin 98293,** Taylor Instrument Companies, Rochester 1, N. Y., or Toronto, Ontario.

*Trade-Mark

Taylor Instruments
MEAN ACCURACY FIRST

Unusually Fast Response. Due in part to its extremely small bulb, the SENSAIRE transmitter has an unusually fast speed of response. However, for processes that require it, the SPEED-ACT* (derivative response adjustment) unit is available. The SPEED-ACT feature is of special value where the bulb is placed in a well, or in processes using material with poor thermal transmission rates.

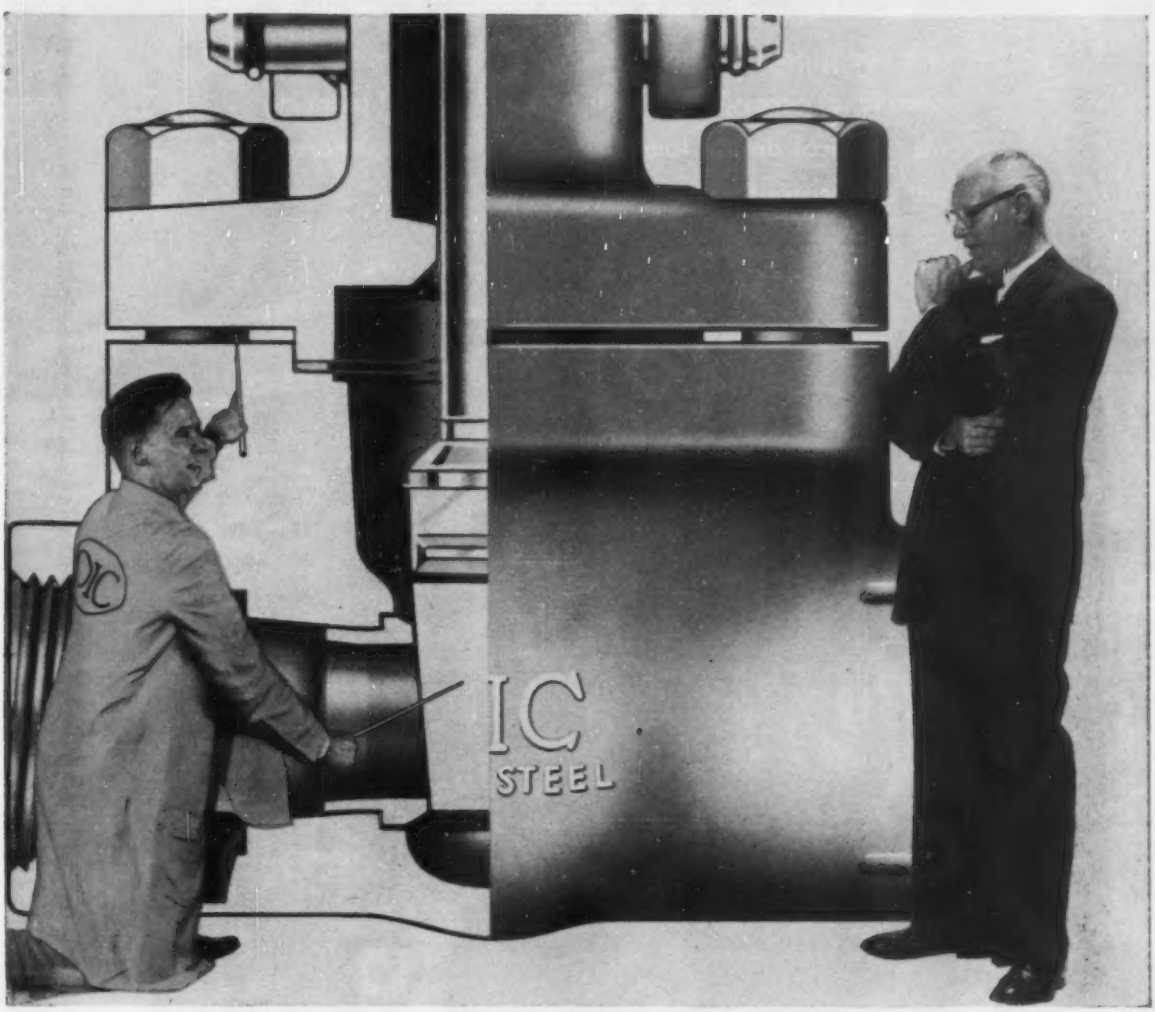
Easy to Install. Mounts in any position. Universal bracket provides for direct mounting on pipe, wall, or wrench head of well or separable bushing. Small and extremely compact, the SENSAIRE transmitter measures only 7¾" x 4¾" x 4½"; weighs only 7 lbs.

For more data on advertised products, use Readers' Service Cards, last page.

...and you can see here....and here,

how we've killed maintenance problems

on our new forged steel lines.



We stop galling and erosion by giving you 13% chrome stainless steel trim with wedges *duracased* to a rugged *1000 Brinell hardness.*

The square and *bolted* body-bonnet joint makes it easy to service the valve quicker. And it's a tighter joint, made doubly leakproof by recessing the soft iron gasket into the body. The gasket can't blow!

And you get the fastest joint make-up you've ever seen. Look at those pipe ends. See the extra wrench-gripping area and lugs. See how body-bonnet flanges are out of the wrench's way. No time lost here!

These new 600-lb. OIC forged steel valves are available with either *high-flow* ports (1300 line), or *standard-flow* ports (1100 line). Call your OIC Distributor, or write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

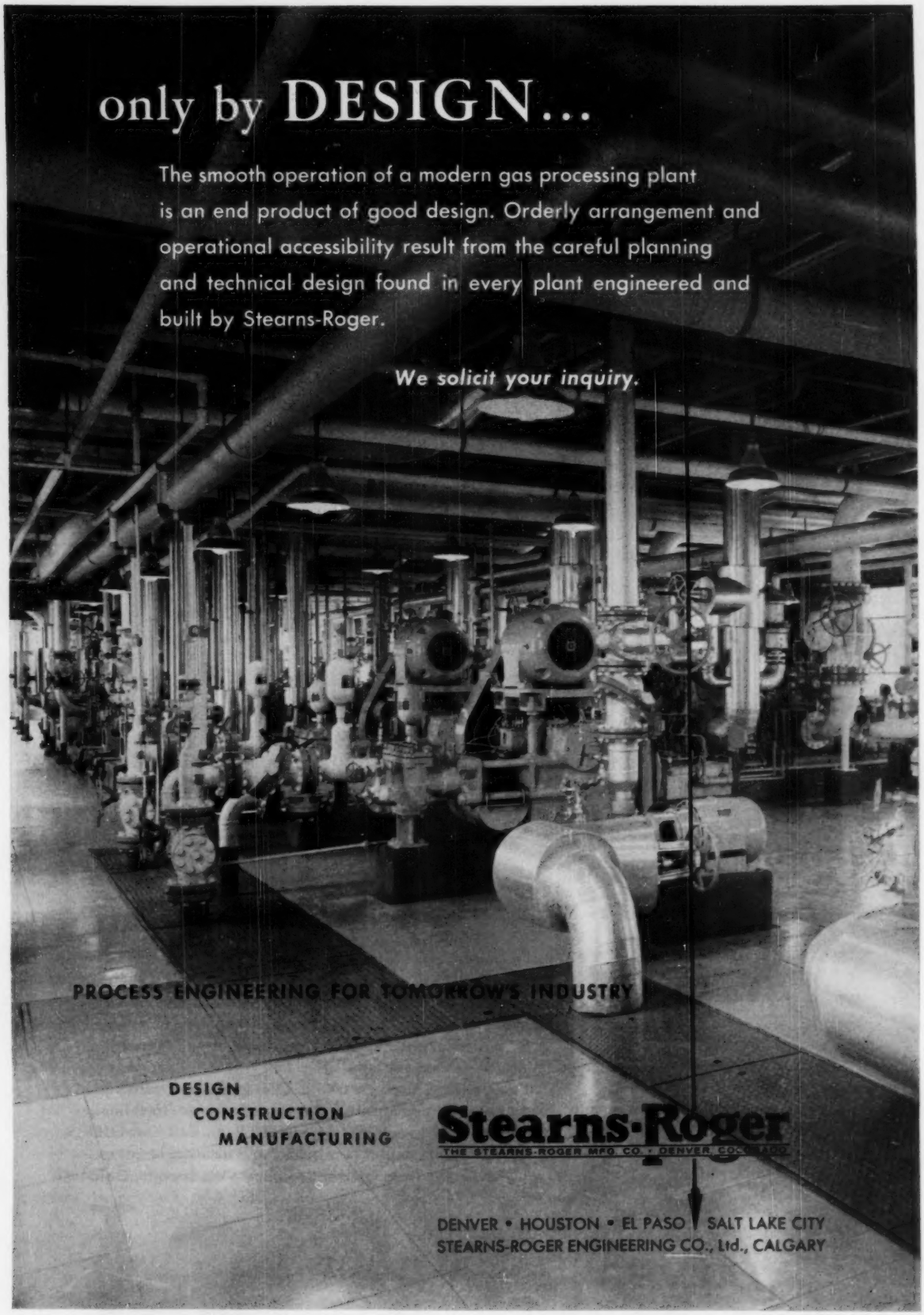
OIC VALVES | BRONZE, IRON, FORGED AND CAST STEEL, LUBRICATED PLUG VALVES

For more data on advertised products, use Readers' Service Cards, last page.

only by DESIGN...

The smooth operation of a modern gas processing plant is an end product of good design. Orderly arrangement and operational accessibility result from the careful planning and technical design found in every plant engineered and built by Stearns-Roger.

We solicit your inquiry.



PROCESS ENGINEERING FOR TOMORROW'S INDUSTRY

DESIGN
CONSTRUCTION
MANUFACTURING

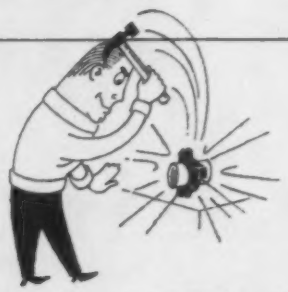
Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER COLORADO

DENVER • HOUSTON • EL PASO • SALT LAKE CITY
STEARNS-ROGER ENGINEERING CO., Ltd., CALGARY

For more data on advertised products, use Readers' Service Cards, last page.

Rocky tells why the Rockwood 603A makes-up without galling



Hardness Differential assures tight seal

The male seat of the 603A is especially treated to make it 150 Brinell harder than the female seat. That means no galling in "make-up." Both seats are made of corrosion-resistant AISI molychrome steel.

Acme Speed Thread and nut extra strong

The lugs will not deform — even when hit with a hammer! And one lug is in position at all times. These speed threads also assure quick "making" and "breaking" in service.

"Rockwoodizing" assures corrosion protection

A special coating process, applied after threading, protects the entire union including the quick-opening Acme thread from corrosion.

Exclusive cold forging process assures interchangeability

Rockwood's exclusive cold forging process results in completely interchangeable parts and higher resistance to tough working conditions.

Get the Union with hardness differential

Strength, interchangeability, corrosion-resistance, Acme speed threads — name it and the Rockwood 603A Tri-Lug Union has it.

Write for complete information. Mail coupon today. The Rockwood 603A Union is tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD SPRINKLER COMPANY

Distributors in all principal industrial areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2824 Harlow Street
Worcester 5, Massachusetts

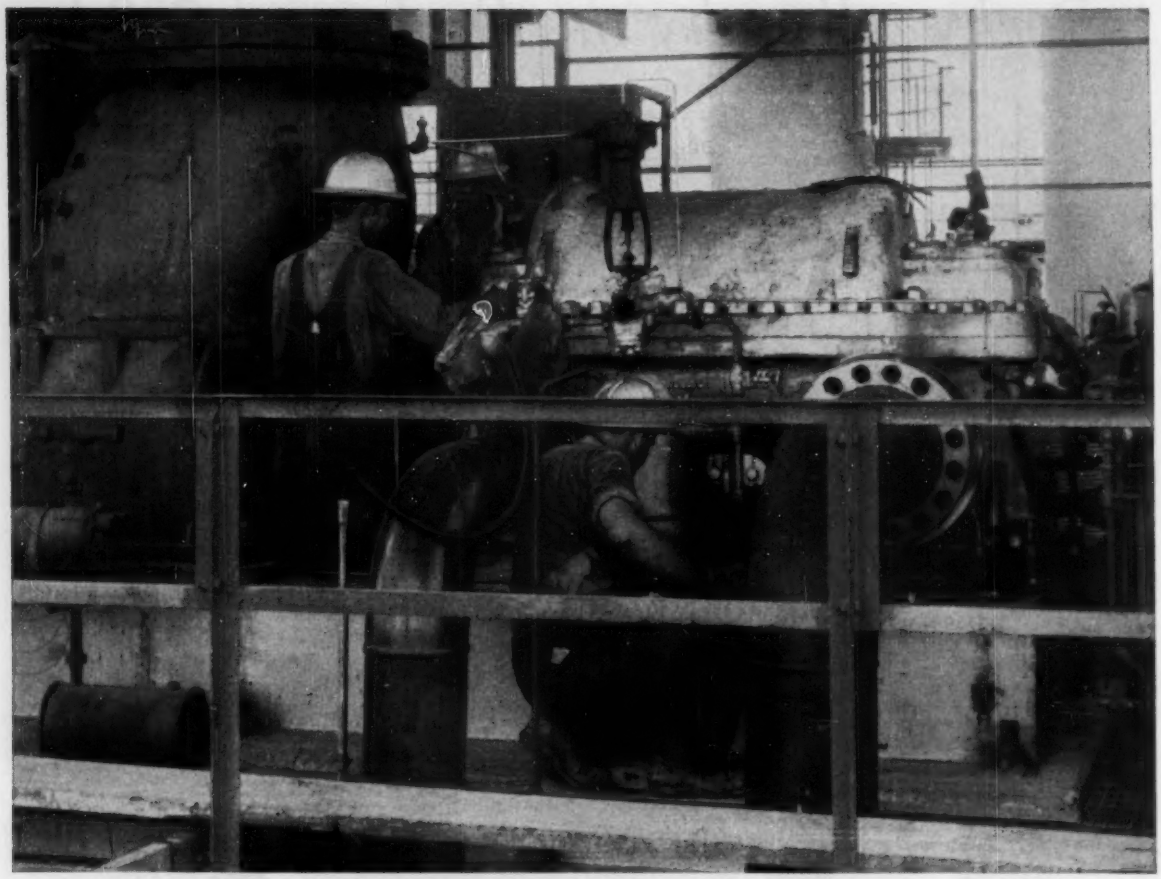
Please send me prices and further data on the Rockwood Unions.

Name.....

Title.....

Company.....

City.....*Zone*...*State*.....



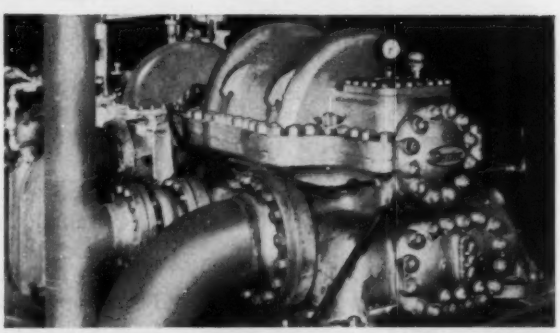
Ethylene compressor being installed at refinery of leading oil company for operation at 600 psi, as low as −185° F. Compressor halves are cast from 4½% nickel steel to resist low temperature impact.

New ethylene compressor works at −185°F ...it's made of cast 4½% nickel alloy steel

Temperatures down to −185°F . . . pressures up to 600 pounds per square inch . . . mean greater efficiency for this ethylene compressor. But these extreme operating conditions increase the danger of low temperature embrittlement. To protect the compressor against cracking, Carrier Corporation of Syracuse, N. Y., specifies cover and base in 4½% Nickel, low carbon steel . . . an alloy with remarkable impact strength at "deep frozen" temperatures.

For the compressor impeller, designers specified heat-treated 2340, 3½% nickel alloy steel. This forged steel, too, provides strength and toughness at low temperature.

Where low temperature puts special emphasis on shock resistance in your process equipment, it will pay you to check the advantages of cast or wrought nickel alloy steels.



Closeup of #350 Carrier compressor, similar to unit shown above. 4½% nickel steel cast upper half weighs 4200 lb, lower half, 5800 lb.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

For more data on advertised products, use Readers' Service Cards, last page.

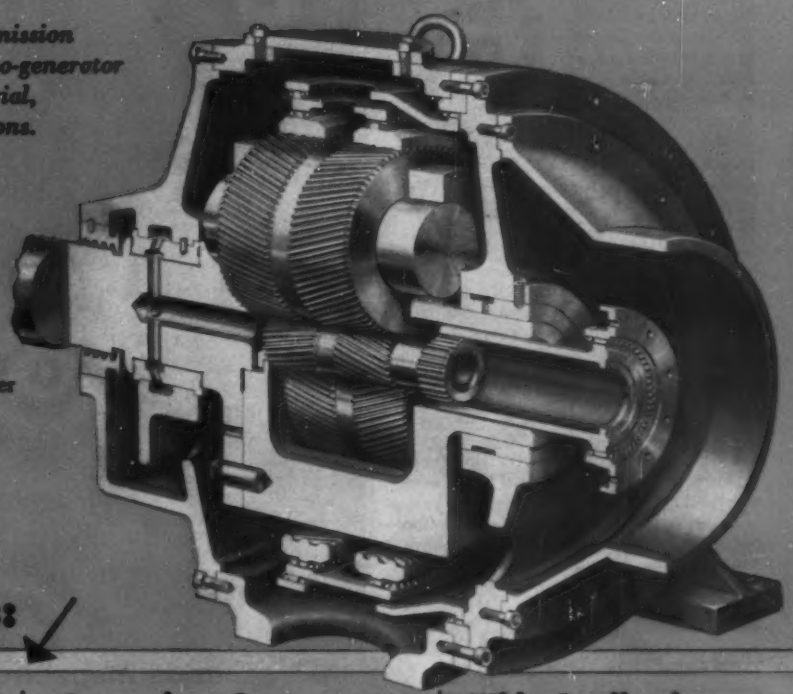
DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

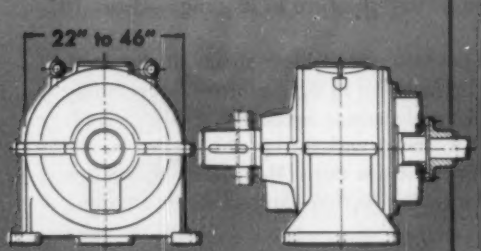
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)...no high speed bearings...less friction losses.



Check These Advantages:

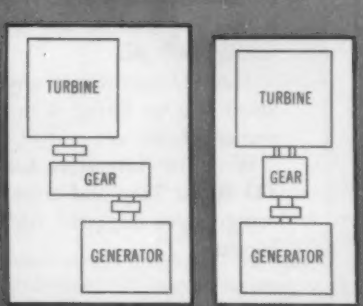
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



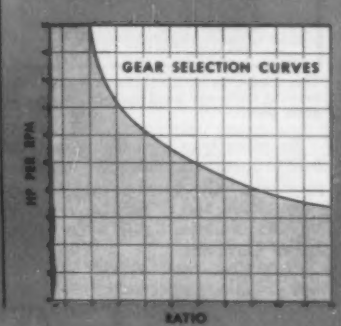
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

811 Nottingham Way, Trenton 2, New Jersey

Simplicity in steam traps can effect big savings in parts inventory and maintenance time

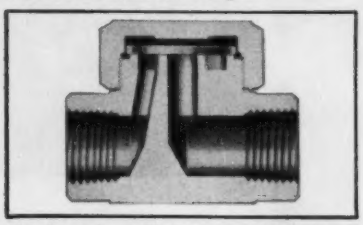
by John W. Ritter, Test Engineer
SARCO Company, Inc.

The function of all steam traps is to release condensate and prevent steam loss. However, the method of trapping can make a great difference in cost and effectiveness.

In the Sarco Thermo-Dynamic Steam Trap, the method is fundamental. Air or condensate entering the trap must flow from the inlet tube, radially across the underside of the disc valve, to the outlet. The space between the inlet tube and the disc forms a nozzle in which the static pressure energy of the incoming fluid is partly changed to velocity across the underside of the disc, with a resultant *decrease* in pressure. (This will be recognized, of course, as the Bernoulli Principle.) Use of this fundamental method means reliability in operation.

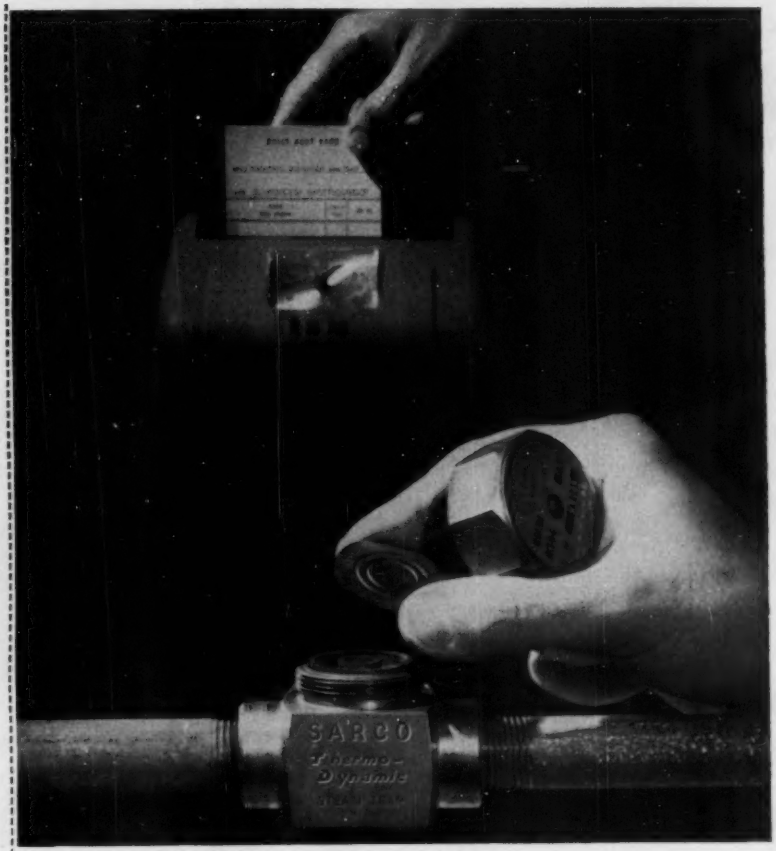
As the high velocity fluid jet strikes the side of the upper chamber, some recompression takes place, so that the pressure above the disc becomes greater than the pressure below it. The pressure reduction under the disc and the pressure recovery above it depend on the internal energy of the fluid. As the condensate above nearly approaches steam temperature, its internal energy is enough to overcome the upward force at the inlet tube and the disc snaps down in the inlet tube, which is the inlet valve seat.

Simultaneously, the disc also seals the outer ring, which isolates the space above the disc from the outlet. The disc valve is therefore held firmly against the inlet valve seat until the pressure in the control chamber is reduced by condensation. The upward force then exceeds the downward force and the disc valve opens.



This 3-part Sarco TD Steam Trap has only one moving part—the hardened, polished stainless steel disc.

No other trap uses the velocity of the fluid to operate the valve or uses the recompression of the flowing fluid to trap the valve closed and to hold it closed. When it closes, it closes tightly – no "operating steam" leaks out.



40 seconds inspection time— that's all it takes for a SARCO TD Steam Trap

Just back off the cap of a Sarco TD. Lift out its single moving part, the stainless steel disc. Wipe it off, and drop it back. No adjustment is ever required, at any load or any pressure in its range – from 10 through 600 psi.

The TD operates in any position, won't blow steam at any load. Small as a tee fitting, it can be installed in tight places. Its versatility and reliability cut cost of big replacement inventory.

Write for "Literature Kit 2A" today and get latest bulletins on the TD Steam Trap and other Sarco steam traps. Remember that Sarco can give you impartial advice on *Production Planned steam trapping* because . . .

5605-B

SARCO
COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

Only Sarco makes all 5 types:
Thermostatic • Liquid Expansion • Float Thermostatic
Thermo-Dynamic • Bucket

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALISTS

For more data on advertised products, use Readers' Service Cards, last page.

News and Notes on...

Good Packing Practice

JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

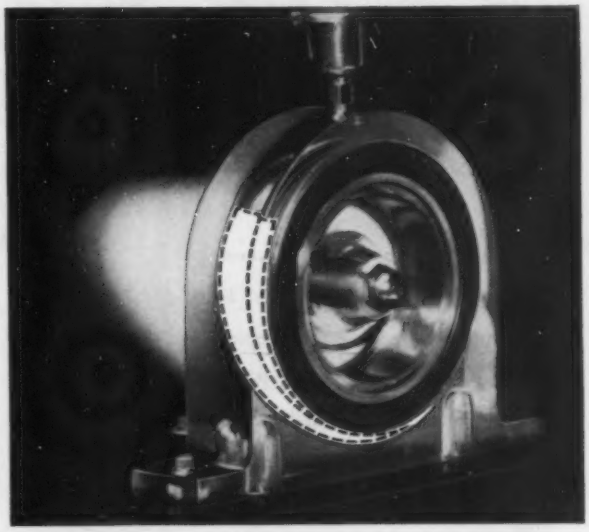
Subject of the month: Effective Shaft Sealing

Question: What is an economical way to seal in or seal out with maximum efficiency?

Whether the shaft bearing is of the sleeve, roller, or ball type . . . seals should meet two basic requirements: (1) provide a tight seal despite light applied pressure, and (2) resist abrasion and corrosion.

The transparent unit shown at the right was created by research engineers to study this subject of effective sealing . . . witness the performance of J-M seals in development stages. It helped them perfect the versatile, dependable line of J-M Clipper® Seals that serve many industries.

In this unit, Clipper Seals are mounted on a transparent cylinder, just as in a bearing cavity. The heel of the seal provides the rigidity essential for a press fit. The lip is flexible and soft so as to snug the shaft with a minimum of friction. Thus it acts like a gasket and effectively stops leakage.



HERE ARE JOB-TESTED RECOMMENDATIONS FOR COMMON SEALING APPLICATIONS:

For General Service—Type LPD All Purpose. This line-contact Clipper Seal provides long life and maximum sealing effectiveness under a wide range of equipment variables. Its synthetic rubber base compound is recommended by J-M for most sealing lip applications where combined ambient and operating temperatures reach 250°F and higher. It seals practically all fluids . . . has proved highly effective against oils and greases, hot and cold water, air and many other gases and vapors. And it maintains its high efficiency despite time, high temperatures, and adverse conditions.

For Small Clearances—Split Clipper Seals. Split Clipper Seals have wide acceptance as temporary replacement seals for equipment with space or design limitations . . . to save costly downtime. Installation in inaccessible space is relatively simple and speedy. They are practically fracture-proof . . . stand up under the rough treatment . . . can be forced into position around the shaft. They give long-term, efficient sealing until a major overhaul permits replacement with solid seals.

For further data on Clipper Seals write for Book PK-71A. Address: Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

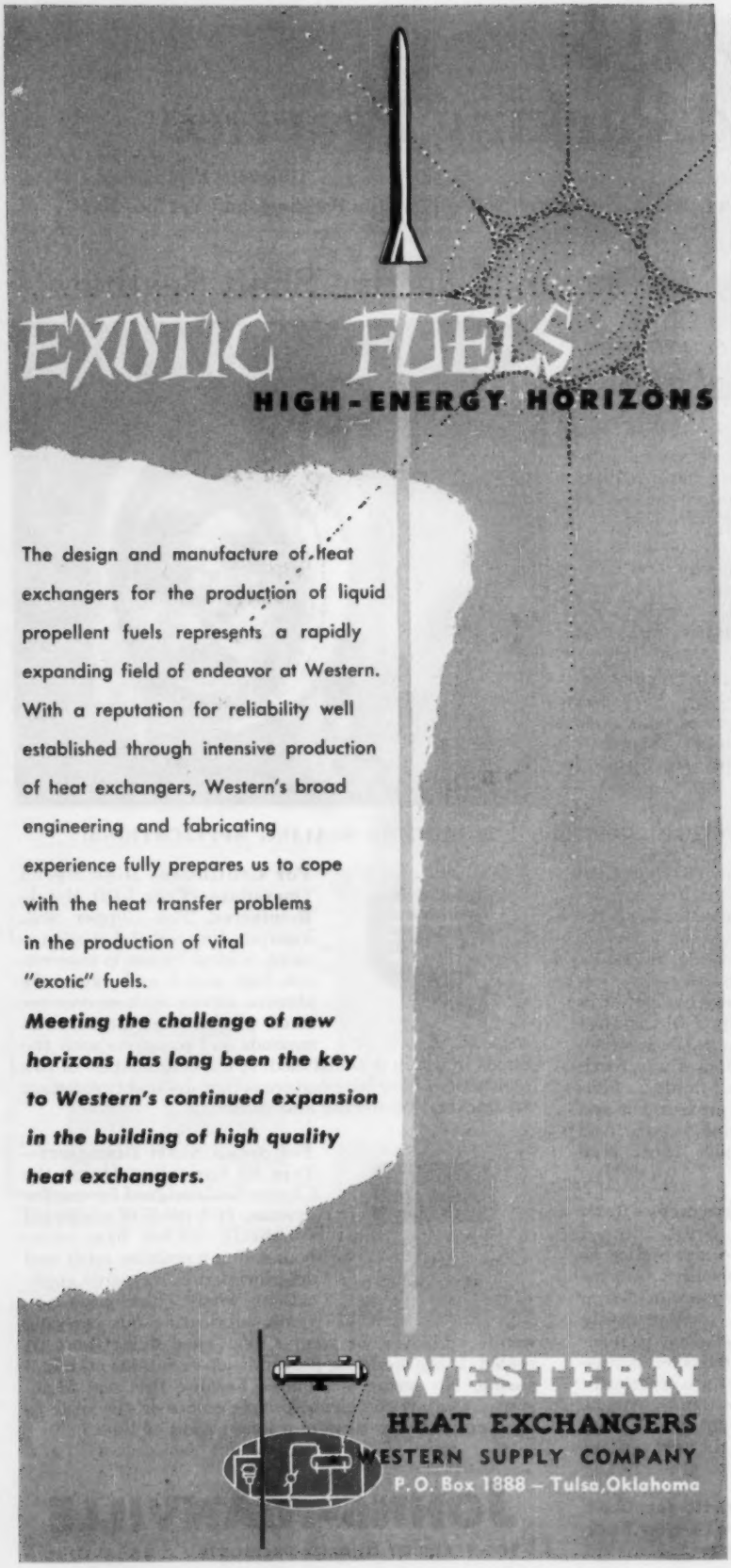
For Continuous High Speed Operations—Type LPD Metal-Reinforced. This Clipper Seal, incorporating a metal reinforcement, is ideal for use in continuous high speed and extremely abusive service such as encountered in the steel industry. It expands and contracts with the chuck in which it is installed. It is a combination of two synthetic rubber base materials that are highly resistant to cracking, hardening and shrinking.

For Small Shaft Diameters—Type SS Springless. Here's the Clipper Seal designed for smaller cavities. It is made of a selected synthetic rubber base compounded to minimize swell and deterioration in corrosive applications where chlorinated solvents, lubricating oils carrying severe additives, or similar aggressive fluids must be sealed. It is a complete part in itself—contains no metal spring. No spring is required because this seal is designed to exert sufficient lip interference on the shaft to compensate for wear over a long period of time.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

For more data on advertised products, use Readers' Service Cards, last page.


EXOTIC FUELS
HIGH-ENERGY HORIZONS
The design and manufacture of heat exchangers for the production of liquid propellent fuels represents a rapidly expanding field of endeavor at Western. With a reputation for reliability well established through intensive production of heat exchangers, Western's broad engineering and fabricating experience fully prepares us to cope with the heat transfer problems in the production of vital "exotic" fuels.
Meeting the challenge of new horizons has long been the key to Western's continued expansion in the building of high quality heat exchangers.
WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma

The Mail Box . . .

Doing Public Service

To The Editor:

Please reserve for me 100 reprints of the article "How Du Pont Combats Alcoholism" which is to appear in an early issue of PETROLEUM REFINER.

It was gracious of you to give me this advance information and I am looking forward to reading the new article telling of Du Pont's latest approach to the problem. I am sure it will be of great help.

You are doing much good and performing a public service with your continuing interest. In my opinion, industry presents a fertile field in the area of prevention by information.

J. Collis Ringo, Executive Director
Kentucky Commission on Alcoholism
Frankfort, Ky.

Guide Gets a Quote

To The Editor:

I have recently been concerned with the problem of "speeding up" our drafting time, and your article "Six Steps to Better Drafting Practices" is of particular interest to me. We have already adopted several of the techniques you suggested. We use single-line piping drawings and isometric drawings whenever possible. However, my biggest problem is the resistance to change. Engineers and draftsmen alike are reluctant to change their standard procedures. Now that I have an author I can quote I don't expect as much resistance.

A. J. Klein,
Petro-Tex Chemical Corp.
Houston.

To The Editor:

Your article on design drafting which appeared in the August 1958 PETROLEUM REFINER, page 133, is extremely interesting.

We would like for several people in our drafting section to study this report. Is it possible for us to get reprints of the article? If so, we would greatly appreciate your sending us six copies.

T. L. Cantrell,
Gulf Oil Corp.
Philadelphia, Pa.

Commends Report

To The Editor:

Your December, 1957 issue of PETROLEUM REFINER contained such a fine section on disaster planning, we should like to have a second copy. This copy is for our Division of Emergency Medical Services which is charged by the Governor and the State Civil Defense Coordinator with all medical and civil defense health planning. Congratulations for the excellent job.

W. L. Wilson, M.D., Director
Division of Occupational Health
Austin, Texas

One Too Many

To The Editor:

On page 9 of the September issue under heading "Commercial Jets Boost Kerosine Need" a statement is made that Boeing 707 consumes 20,000 gallons per hour. On an overseas flight of six hours the plane would use 120,000 gallons. Is this an error?

Sidney Tonner
New York

Editor's Note—Mr. Tonner is right in that there was one too many zeros on the fuel consumption. The correct figure is 2,000 gallons per hour.

Pin your motor oil improvements on the Amoco Additive line

Detergents
Inhibitors
Detergent-Inhibitors

Detergents. Amoco barium and potassium salt detergents have exceptional properties. When blended with your oils, they effectively neutralize acids and hold products of combustion and other contaminants in suspension in high- or low-temperature service.

Inhibitors. Two types of Amoco inhibitors are available—a sulfurized hydrocarbon and a zinc dithiophosphate. In finished motor oils they: (1) protect against bearing corrosion, (2) inhibit oxidation and protect against sludge and varnish formation.

Detergent-Inhibitors. Specially tailored blends to provide all of the performance characteristics desired in your finished motor oils.

The complex science of motor oil blending requires that men who market additives be experienced in this work. The men who sell Amoco Additives are engineers who have both laboratory and field service experience. Inquiries about Amoco Additives get their immediate attention.

AMOCO
CHEMICALS

AMOCO CHEMICALS CORPORATION
910 South Michigan Ave., Chicago 80, Illinois

A message to every engineer who wants to
keep fluid mixing costs down

Don't be fooled by *low purchase price* when you specify mechanical mixers for fluids.

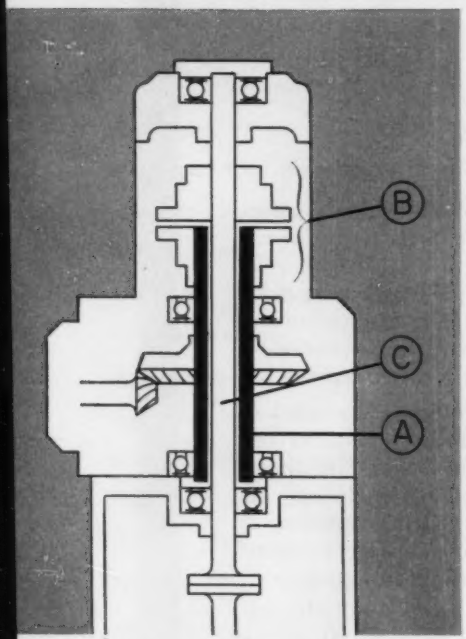
First cost is a very small fraction of your total mixing cost.

To find the *real* savings, look behind the price tag. Which mixer design will give you simplest, cheapest maintenance over the years? Most dependable month-in, month-out service? Greatest adaptability if mixing conditions change? Lowest spare-part requirements?

These are the areas where you can *really* save money on fluid mixing. And here are some of the reasons why you can do it more surely with LIGHTNIN Mixers than with any other mixer available.

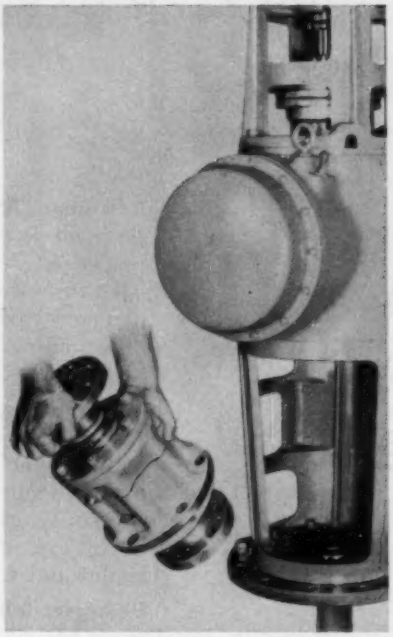
For lower-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Refinery Catalog. Or write us direct.

Only *Lightnin* Mixers cut your mixing costs these 3 ways



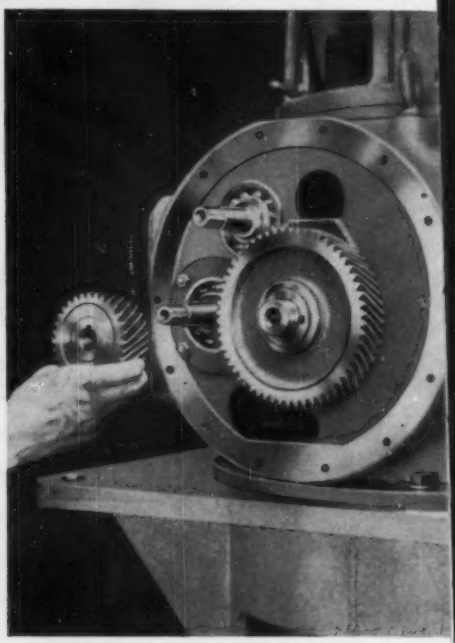
1. PROTECTED GEARING. Ever think what could happen to a mixer's gearing if something in the tank should accidentally damage the shaft? Shocks or flexures *don't reach the gears* in a Series "E" LIGHTNIN Mixer. Hollow quill* (A) isolates gearing from shaft. Flexible coupling (B) transmits power from gears to shaft—soaks up mixer shaft loads. Mixer shaft (C) is easily removed without risk of disturbing gear alignment.

*Patented



2. EASIER, SAFER SEAL CHANGE. Cartridge-type rotary mechanical seal† eliminates leakage under pressure or vacuum, runs for years without adjustment, and can be replaced in minutes without skilled manpower *and without disturbing gearing or shaft alignment.* Basis of this extra safety and convenience is the hollow quill of the reducer, which lets mixer shaft move up and down freely. You get this construction only with LIGHTNIN Mixers.

†Patent pending



3. INTERCHANGEABLE SPEEDS. Should your mixing requirements ever change (within the mixer's rated limits), you can quickly adapt your LIGHTNIN to meet the new needs. Change gears‡ provide as many as 16 standard AGMA output speeds from the same basic drive. You can change speeds without dismantling the mixer or removing it from the tank. This cost-cutting feature, like all the others shown on this page, is a LIGHTNIN "first."

‡Patented

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU?
You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Side entering: 1 to 25 HP (B-104)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-k Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® Mixers™

MIXCO fluid mixing specialists

It's Our Last Line of Defense

AN OIL COMPANY finally has decided that someone had better start moving fast to counteract unionism's mounting political power. Gulf Oil Company's management has reasoned, and rightly so, that labor's attempts to influence Congressmen and legislation calls for opposition from a matching force—and nowhere in the United States can such a force be generated as well as by industry.

American business interests had better take a good long look at Gulf's decision to stand up and fight. Very likely we have reached our last line of defense—a defense that is imperative if we hope to check this country's headlong flight down the economic path to socialism.

A few months ago General Electric Company announced its decision to start talking less and doing more in politics. Now Gulf has entered the ring, and it is certainly the duty of other American industrial firms to rise and stand shoulder-to-shoulder in the continuous fight.

Some may scoff that the situation is being overplayed, and that the political activities of labor are really nothing to worry about. Of those uninformed—or misinformed—we ask this question: "Why, in the light of shocking revelations of the McClellan Committee concerning extortion, gangsterism and worse in labor unions, has Congress done nothing to restore law and order in labor-management relations?"

Beholden to Unions. The answer is found quite easily in the words of Congressman Ralph W. Gwinn, New York, and what he says is both enlightening and frightening. "There isn't a chance that such legislation will be passed," says Representative Gwinn. "First, you should know that labor—or rather the top officials of labor—dominate Congress; over 175 members of the House have benefitted from union contributions, free campaign help, radio and TV time, advertising, extensive publicity in the labor press, scores of voluntary workers furnished by the unions, doorbell ringers, telephone brigades, and all the rest of it. Business organizations do none of this. Business is unorganized politically and therefore impotent."

Union leaders thus manage to get elected men who are not only favorable with Union programs, but who feel definitely obligated for campaign help from that source. These elected politicians will not be biting the hand that feeds them. On the other hand, business is not sufficiently organized to pack a political punch. We can feel quite certain Congress knows what legislation is needed—it's just that the votes cannot be mastered to pass the required bills.

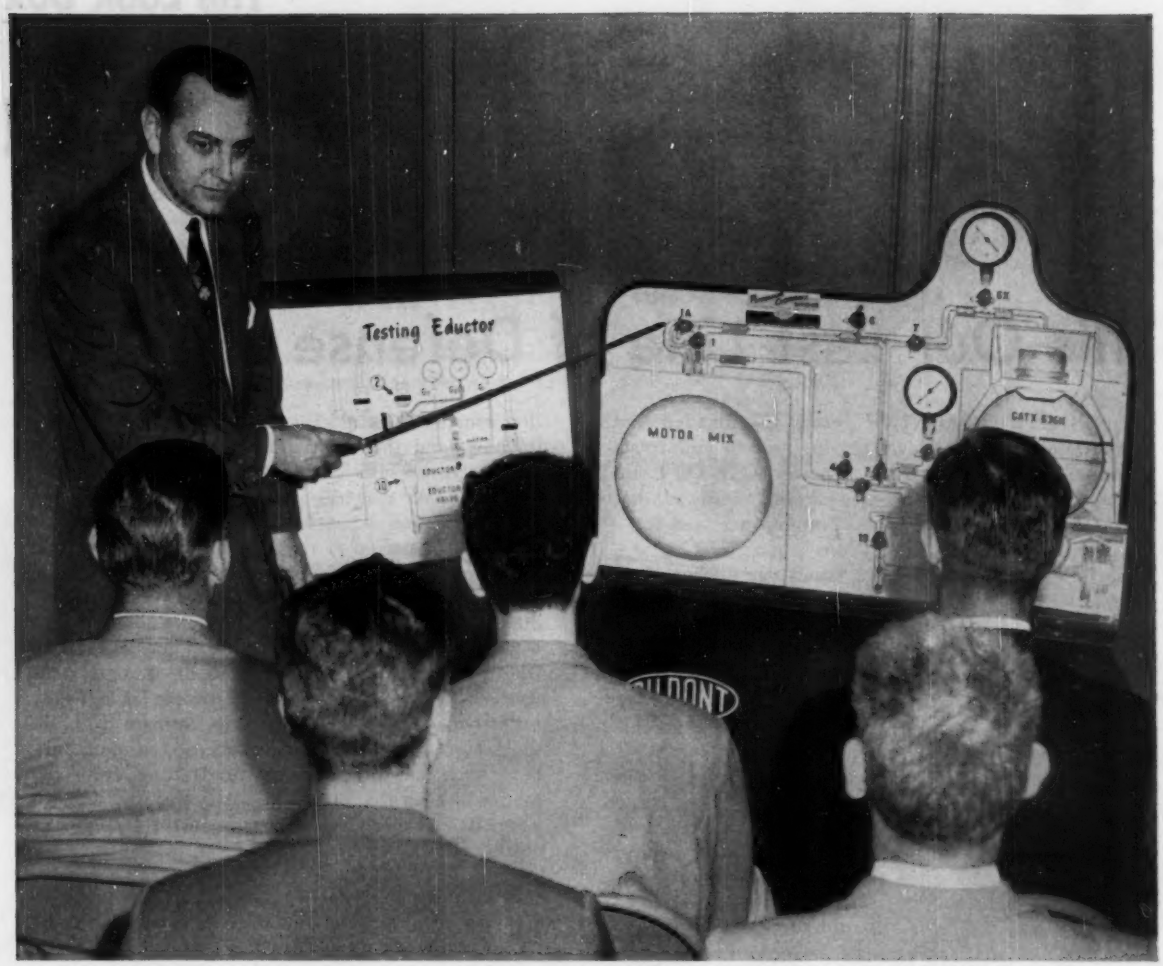
Columnist David Lawrence reported recently in *U. S. News and World Report* that "because of industry-wide bargaining and the tremendous power wielded by national labor unions, a battle is being waged between Big Unionism and Big Business that concerns our whole economy . . . people as a whole suffer because Congress hasn't the courage to tackle Big Unionism. That's perhaps because too many millions of dollars of campaign funds come from the unions to elect the Democratic majority and to infiltrate the so-called 'liberal' groups in the Republican party."

Monopolistic Growth. So the Union monopolies continue to grow, and the cries that arise for some lid on wages and prices to check our spiraling economy are too few and too feeble to be heard. Union officials feel that when 12 months pass, that is the automatic signal for another hike in the pay scale. As a consequence, Union monopolies, immune from any antitrust laws are using their industry-wide bargaining privileges to pile up victory after victory while intimidated legislators sit idly by.

But it's not only on Capitol Hill that the Unions are making political hay while a benevolent congress shines on them. Take this case reported in *Newsweek,* March 10, 1958: Local 974, United Auto Workers was "in the midst of a determined effort to capture the Democratic machinery in Peoria, Ill., for the union. If its forces won out—and the test would come in April's Democratic primary—there could be little doubt that UAW headquarters in Detroit would consider Peoria as a pattern for action in many other industrial areas . . ."

Newsweek also quoted a subregional director in Peoria as saying, "Although I am the one who implemented this move in this particular area, it is really a national program out of Detroit. We are started on a course that will allow us to deliver Illinois in 1960 to the candidate we think best for labor."

And don't think for one moment that any differ-



TYPICAL TRAINING SESSION conducted by Ron W. Beecher, Du Pont's Central Region Operations Coordinator, using scale-model blending plant to show safety procedures in unloading and weighing TEL from tank car.

Du Pont offers on-the-job training program for economical handling of tetraethyl lead

Du Pont helps refiners train new personnel in handling tetraethyl lead safely, economically and efficiently. The course proves of value also as a refresher for experienced personnel. Du Pont takes the "classroom" right to the refinery and teaches the fine points, as well as the fundamentals, of tetraethyl lead blending.

Dramatic Visual Aids

A scale-model blending plant, turnover charts, and cutaway valves, eductor and flex hose are among the training tools used. They graphically show employees the why as well as the how of following prescribed procedures.

The course is presented in two parts: the theory, or classroom, sessions—in which are presented the reasons behind various techniques. Here visual aids are used. Then come the practice, or on-the-job, sessions. During these, personnel go through the actual step-by-step unloading and blending of TEL, with running commentary by the Du Pont instructor.

If you are interested in this service, get in touch with your Du Pont representative. He can make all arrangements for presenting a training program at your plant.

E. I. DU PONT DE NEMOURS & CO. (INC.), Petroleum Chemicals Division, Wilmington 98, Delaware.

DU PONT
Better Things for Better Living . . . through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

ences of opinion with respect to either issues or candidates will be tolerated by these professional labor politicians. James L. McDevitt, co-director of the AFL-CIO Committee on Political Education was positive on this when he spoke recently in New England:

"These so-called labor leaders that differ with the movement will be uncovered. We plan to, and we will, publicly and among the rank and file, brand them as traitors. We are warning you, and we are warning all in the future: Do not differ with the movement with respect to issues or candidates. We will not stand for it."

Thus the die is cast—the pattern of Big Union politics is clear and as things stand now, the efforts of the regular political candidate with his volunteer workers will be no match for the thousands of full-time union officials and employes who can work night and day for the Big Union choice.

Long, Careful Planning. The management of Gulf Oil has kept an eye on these Big Union activities, and has finally concluded that Gulf—as well as other American industrial companies . . . are up to their corporate ears in politics, and all must start swimming together or each will surely drown. So Gulf has decided on a course of action and has already started some long and careful planning.

The program formulated likely will be too late to be effective in the state and local elections next month. For this reason, Gulf is urging its employes, dealers and stockholders—and we sincerely hope that all other oil companies will consider following suit . . . to take a more active part in local politics. Take a closer look at the candidates for Senate and House in the upcoming elections to make sure they are worthy of support, Gulf is saying.

"If our free, competitive institutions are to be preserved from destruction by the unholy combination of predatory gangsterism and crackpot socialism that is thriving and expanding under labor's congressional benevolence," concludes Gulf, "then business has no choice. It must do likewise or throw in the towel."

With each successive licking, industry has retreated further and further until now—where is there left to go? Truly—this is our last line of defense!

The Right Way For Washington

IN THESE DAYS of a $3 billion deficit for a federal fiscal year ended June 30 and a prospective $10 billion deficit for the one starting July 1 this thought cannot be considered irrevalent or immaterial:

Reduction in government spending is the only out for the taxpayer, the only path that might lead to a cut in the tax rate.

We stand for a balanced budget. When that is accomplished, we favor a reduction in the tax burden. Neither can be accomplished unless Washington about faces, abandons its policy of ever-increasing spending not only for essentials like defense but also for, as the *Wall Street Journal* puts it, "a whole flock of activities the government has no business engaging in anyway."

Civilization's Disgrace

INDUSTRY IS CONTINUING its fight against air pollution, a late figure indicating that some $300 million per year is now being spent to install and maintain anti-pollution equipments at U. S. plants. Processing companies, of course, are included by the score in the list of companies engaged in this fight.

Doubtless more companies should be concerned with this effort and there is no question but the sky's about the only limit on what might be spent.

However, the public must be reminded that industry is not the sole source of pollution. In fact, residents of areas affected—and they are the ones who complain loudest—are the largest contributors to air pollution. A long line of autos returning into a city after a weekend drive is equivalent to moving a smelter into that city, Dr. W. L. Faith, managing director of the Los Angeles Air Pollution Foundation testifies. But an average industrial plant contributes more to the nuisance than the average individual; so public eyes turn toward industry to do the cleanup.

So into the pot goes some $300 million per year in which, incidentally, is perhaps five times the amount spent for this purpose 10 years ago.

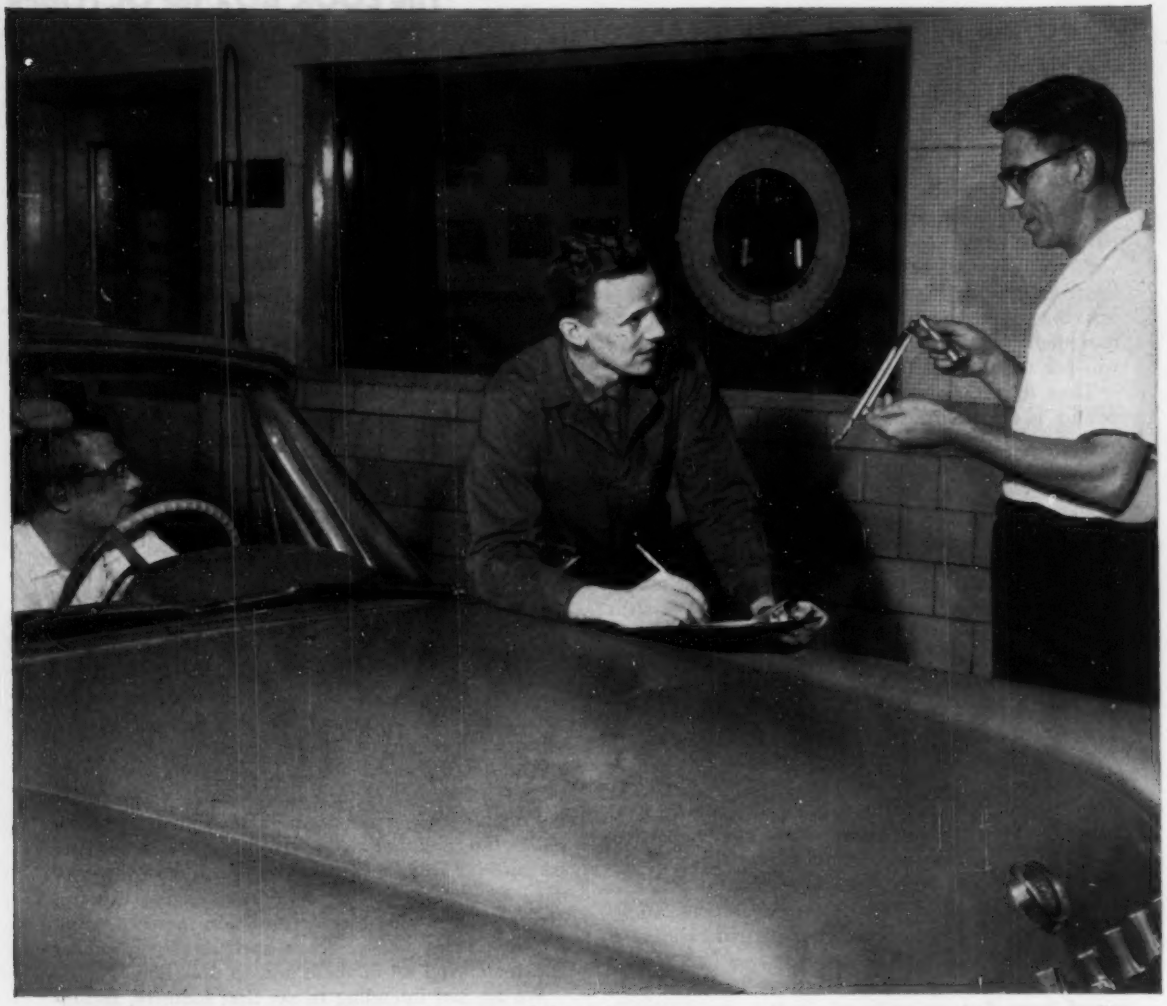
And no matter how much the industrial world spends in the future for combustion of waste material, elimination of odors and a minimum release of smoke, air pollution will persist to varying degrees. Because industrial plants have little or no control of open fires, trash incinerators, auto engine exhaust, dispersion of settled dirt, construction material, plant pollens and groundup debris such as paper, rubber and food. And all of these add to pollution.

We are not intending to say that industry, including processing, should go scot free in this effort to eliminate air pollution. They are contributors, but certainly are not alone as to culpability.

The nuisance—and sometimes dangerous hazard—is with us and all contributors, industrial plants and individual residents alike, should do their utmost, as the ways are pointed out, to get rid of the blight.

Armour Research estimates the pollution of U. S. atmosphere costs some $4 billion annually in cleaning bills, corrosion and other items. And in addition there is the very definite health hazard. When you realize that 9,500 communities in the U. S. (800 in the 25,000 or more bracket) are plagued with the problem it becomes obvious that pollution is as extensive as it is serious. And also, that actually we are helping ourselves when we help to find and root out the causes of what could well be tagged one of the disgraces of civilization.

We wonder if some of our present day unionists ever heard of this very wise saying by Samuel Gompers, one of their pioneer leaders: "The worst crime against working people is the company which fails to operate at a profit."



Checking humidity control setting in one of Ethyl's controlled-weather rooms

Ethyl Research reports the effects of temperature and humidity on fuel road ratings and octane number requirements

ETHYL Corporation's policy of keeping significant research data up to date and usable has produced a new study of the influence of weather and associated engine variables on fuel road performance and engine octane needs.

Refiners can use the results of this study to evaluate the effects of weather on the high-octane fuels they are producing for the high-compression engines of today.

In 1953 a similar study was conducted by Ethyl engineers. The results were published in an S.A.E. paper entitled, "Weather or Knock." The increase in compression ratios and the accompanying rise in octane numbers made it necessary to up-date the earlier research.

In the 1953 tests, cars with compression ratios of from 6.5-to-1 to 7.5-to-1 were tested on fuels ranging from 81.1 to 92.6 RON. This year, fuels from 96.6 to 99.8 RON were used in 10-to-1 compression ratio cars.

Conditions of the 1958 Test Program

The octane number requirements of two test vehicles were determined in terms of primary and commercial reference fuels at a number of combinations of ambient air temperature and absolute humidity.

Road ratings of six test fuels of various hydrocarbon compositions also were studied at these combinations. (See Tables I and II.)

Fuels were selected to represent a cross-section of commercial fuels now available. The Modified Borderline procedure was used in order to show the change in behavior characteristics throughout the engine speed range.

Road ratings were determined in duplicate on a chassis dynamometer in one of Ethyl's controlled-weather rooms at each of the selected conditions of ambient air temperature and absolute humidity shown in Table I.

Summary of 1958 Tests

The following general observations were made on engine octane number requirements (ONR) and fuel road ratings:

ONR increased when absolute humidity was held constant and the ambient air temperature was raised.

ONR decreased when ambient air temperature was held constant and the absolute humidity was increased.

Road ratings of test fuels decreased when the absolute humidity was held constant and the ambient air temperature was raised.

Road ratings of test fuels varied with changes in absolute humidity at constant ambient air temperature depending upon the temperature level and the hydrocarbon composition of the fuels.

It is important to relate the foregoing conclusions in terms of increase or decrease in the ability of a fuel to satisfy engine octane requirements.

With ambient temperature increase and constant humidity, the "satisfaction ability" decreases. "Satisfaction ability" increases with an increase in humidity when ambient air temperature is constant.

Comparison of Old and New Data

Data from the 1953 and 1958 programs agree directionally on the effects of temperature and humidity on octane number requirements, but differ in the magnitude of the change.

With respect to changes in fuel road rating, the new data do not agree with the data in the "Weather or Knock" paper where highly olefinic fuels are involved.

TABLE I

Ambient Air Temperature, °F.	Absolute Humidity — Grains of Moisture/lb. of Dry Air
90	160, 119, 78, and 30
60	78, 57, and 30
35	30

TABLE II

Test and Commercial Reference Fuels

	TEST FUELS						COMMERCIAL REFERENCE FUELS		
FUEL NUMBER	A	B	C	D	E	F	A[1]	B[1]	C[1]
Research ON	97.0	97.3	99.0	99.8	96.6	98.0	96.0	98.0	100.0
Motor ON	83.3	85.4	89.0	86.9	87.2	87.0	85.8	86.8	88.9
Sensitivity (RON-MON)	13.7	11.9	10.0	12.9	9.4	11.0	10.2	11.2	11.1
TEL, ml/gal	2.67	3.0	1.49	0.97	1.49	3.00	1.37	1.43	1.77
Hydrocarbon Type, Vol %									
Olefins	34	42	4	22	5	24	14.7	14.5	12.1
Aromatics	12	14	43	35	39	22	33.8	36.2	39.1
Saturates	54	44	53	43	56	54	51.5	49.3	48.8

How Ethyl Research is helping you

The work described here is one more example of Ethyl's service to the refiners by keeping them informed of latest developments pertinent to the fuel-engine relationship.

The complete report made of this study is available through your Ethyl Representative.

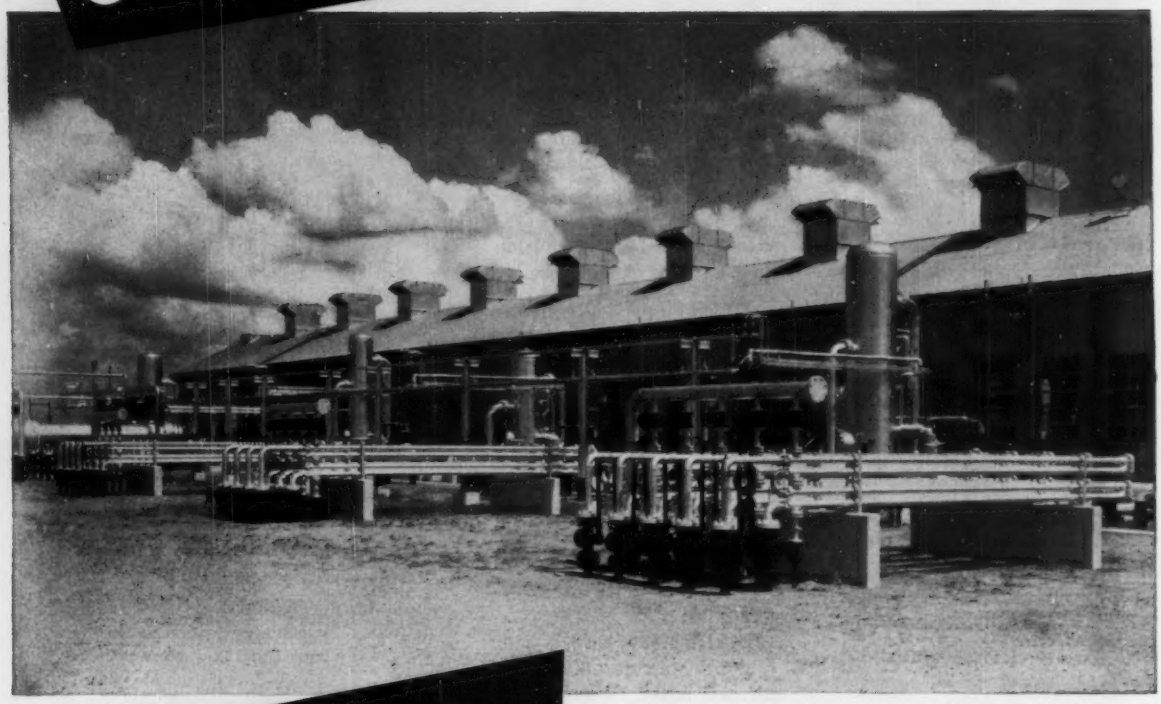
Just ask him for a copy of "The Effects of Temperature and Humidity Changes on Fuel Road Ratings and Octane Number Requirements," or write Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

ETHYL CORPORATION
New York 17, N. Y.

ETHYL ANTIKNOCK COMPOUND ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

Reduce Obsolescence in your plant



with BROWN FINTUBE

sectional hairpin heat exchangers

● Brown Fintube, by manufacturing one standard hairpin section for the majority of heat exchanger duties, has licked obsolescence. From heating asphalt to cooling air, the same basic standard sections are used. A bank can even be broken up and the sections shipped to two or more plants, miles apart, re-assembled and reused. Sections not in use serve as "stores" for other sections on stream. They are never obsoleted by changes in duty or plant rearrangements. You can use and reuse them until they are completely worn out. Estimates and quotations furnished promptly. ***Write for Bulletin No. 512.***

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Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Fired Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integral Welded or Brazed Fintubes for Any Heating, Cooling or Heat Transfer Service

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A PETROLEUM REFINER SPECIAL REPORT

MOTORS

DURING THE PAST 10 years the number of electric motors used in refineries and petrochemical plants has more than doubled. There are probably in excess of 2 million motors of all sizes and kinds in operation today in these industries. The extensive use of motorized equipment emphasizes the importance of electric motors and controls to successful plant operation.

The electrical engineer is only one person who needs to understand their application. He or the manufacturer's representative may recommend electrical equipment for specific drives, but it is particularly desirable for the process engineer to have a clear picture of motor and control applications because their characteristics have a definite effect on the proper functioning of the process equipment.

Thus, the editors feel that it is essential that all engineers be given an article which will give them a good idea of the various kinds of motors and controls available and their principal application.

To achieve this end, we invite you to read the following report.

Frank L. Evans

MAINTENANCE AND DESIGN EDITOR

Selecting Motors and Motor Controls

You'll need to know motor prices in relation to hp, speed, enclosure, motor type and voltage. Follow these steps and pick the right motor for your job

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OVER THE PAST 25 years, the use of electricity in petroleum refineries in the U.S. has quadrupled. To date, more than 4-kw hours of electrical energy go into every barrel of petroleum processed. Most of this powers electric motors. These motors drive pumps, compressors, fans, blowers, conveyors, machine tools; they are the work horse of the petroleum refinery. Because of this large use of electric motors, all the factors relating to their selection should be carefully weighed. The purpose of this article is to give some guides for their selection. Data is given on motor prices in relation to horsepower, speed, type of enclosure, type of motor and voltage. The trends in motor usage are discussed as affected by recent standards action in the American Petroleum Institute and as affected by recent design changes. Motor sizes from 1 to 20,000 hp are covered. This article deals only with squirrel-cage and synchronous motors, by far the most common types found in petroleum refineries. Typical U.S. power sources (three-phase, 60-cycle) are assumed.

RP-500 and The NEC. In 1955, the API issued "RP-500"[1] covering the installation of electrical equipment in petroleum refineries. This work was a result of many years of intensive study and effort on the part of devoted men

in the petroleum industry to arrive at a consistent installation standard for the petroleum industry. This work has only begun to affect the application and selection of electric motors. In the future its effect will be more pronounced. Prior to the issuance of RP-500, there was no standard clearly defining the relative fire hazard of specific refinery areas. The National Electrical Code[2] states in broad terms the difference between a hazardous (Division 1) area and a semihazardous (Division 2) area. This broad statement of principle is not sufficient. When in doubt, the conservative approach was always taken and as a consequence many refineries were considered to be almost entirely hazardous. Today, with the issuance of the definitive standard RP-500, the Division 2 (semihazardous) classification will be used more widely and the Division 1 classification much less. This means a considerable savings in the purchase of electric motors since standard open squirrel-cage motors may be used in Division 2 areas. This fact will lead to an even more extensive use of electricity since it represents a reduction in the total cost of energy.

MOTOR SELECTION

Economic Considerations. Cost is a prime factor in the selection of motors or any equipment. Selection should be based on the least motor (that is the lowest cost) which will meet the requirements. The requirements should be carefully reviewed to ascertain whether they are necessary or simply the product of so-called "conservative engineering." "Conservative engineering" is very desirable as long as the engineer is also conservative in looking at cost. A great deal of care and thought must be put into establishing the requirements to make sure that all the anticipated operating conditions have been met, but that no excess baggage is carried. Two areas of cost should be investigated—operating cost and initial cost or capital expenditure.

The all too common result of improper selection is increased operating costs. For example, oversize motors are commonly purchased either because the actual load requirements aren't known or because of anticipated load growth. The natural tendency is to oversize rather than undersize. Unfortunately, the results of this practice are not all good. Motors perform best (maximum power factor and efficiency) at their rating. Poor power factor and system efficiency cause higher electrical energy costs. Poor system power factor also causes poor voltage regulation and consequent inefficient operation of all motors throughout the refinery. Other performance requirements besides horsepower can also be overstated with the same result. Higher torques than necessary may be specified (at times with no increase in cost), but this sacrifices some other performance factor such as efficiency or power factor. On the other hand, undersize motors may fail prematurely and originate costly shutdowns. However, there are far more oversize motors in operation today than undersize. The best checks against improper sizing are careful review of the drive requirements prior to purchase, periodic checks of the individual motors in operation, and periodic checks of system power factor. When plant power factor is used as an indicator, calculate what the system power factor would be without synchronous motor and capacitor correction.

Serious consideration should also be given to the selection of proper motor enclosures. Obviously, enclosures must provide the degree of protection required for the specific application. If the requiements are understated, high maintenance costs and premature failure can be expected. Conversely, if the enclosure provides more protection than actually needed, the initial cost will be high. Motor enclosures are dealt with more extensively elsewhere in this article and as it will be seen the selection of the proper enclosure for any given application is extremely important costwise.

The type of motor selected (synchronous or induction) affects both intial and operating costs. Synchronous moters are economical to operate because of the high efficiency and power factor. Quite often, however, in the large motor field, induction motors are used where synchronous motors would do a better job at lower cost. Because of habit, induction motors are frequently the only type considered. This is particularly true where size has been continually increasing making more and more applications in which synchronous motors can be used to advantage. A more complete cost study of synchronous motors versus induction motors is also given elsewhere in this article.

The effect on other equipment should also be considered when choosing a motor for a specific application. For example, the variation of motor price with voltage is only one fact in the over-all problem of selecting plant distribution system voltages and determining the motor size at which a shift from low voltage (less than 600 volts) to high voltage (2,400 volts and above) should be made. A careful analysis should be made on the over-all costs not just the motor cost. Costs for the motor, gears, and control equipment, distribution system, and driven equipment should be reviewed.

Finally, a review should be made of the motor requirements and specifications to make sure that all of the unnecessary, non-standard, special features have been eliminated. Each special requirement such as appearance, nonstandard mounting dimensions, nonstandard bearings, etc. should be eliminated unless they are absolutely necessary and serve some useful purpose. Many special features have been inserted into specifications because of an isolated case of trouble years ago. Likewise, some special features may have been obsoleted by changes in refinery practice or changes in motor manufacturing techniques.

Price Estimating. A review of Figures 1 and 2 will show very quickly that no simple, all-inclusive statements can be made regarding cost comparisons between different types and ratings of motors. Some general comments can be made but each specific application must be studied.

Type, Speed and Horsepower. Synchronous motors are not commonly applied in the NEMA[3] ratings, that is 200 hp and below. Up to 200 hp, induction motors have a distinct price advantage. Above 250 hp, however, synchronous motors begin to compete with induction motors. Above 1,000

hp, synchronous motors have a price advantage in many of the speed ranges; and above 4,000 or 5,000 hp, induction motors can hardly be considered. Even turbo-generator type 3,600 rpm synchronous motors become less expensive than comparable induction motors above 5,000 hp. The 1,800-rpm synchronous motor becomes less expensive than the equivalent induction motor at approximately 400 hp. At 1,200 rpm, the synchronous motor has a price advantage down to 250 hp if the exciter and additional control equipment costs for the synchronous motors are not considered. Above 200 hp, at all speeds below 1,200 rpm, the synchronous motor has a price advantage.

Synchronous and induction motors cannot always be compared on an equal speed basis. In geared applications such as high-speed (above 3,600 rpm) centrifugal-compressor drives, the most economical induction motor speed is usually 1,800 rpm. The most economical synchronous motor speed for the same application might be 900, 1,200 or even 3,600 rpm depending on the horsepower required. A 1,200 rpm synchronous motor and gear would be definitely less expensive than a 1,800 rpm synchronous motor and gear. Above approximately 5,000 hp, the 900 rpm synchronous motor and stepup gear unit is less expensive; and above 10,000 hp, it is seen that a 3,600 rpm synchronous motor might be the best buy. Therefore, for compressor drives and other high-speed applications above 3,600 rpm, motor prices must not be compared directly speed-for-speed and horsepower-for-horsepower, but must be studied with the "whole job" concept.

For 3,600 rpm pump and compressor drives below 5,000 hp, simplicity of the installation almost dictates using the 3,600 rpm induction motor. No gear is required and the over-all electrical and mechanical installation is the simplest possible.

For pump and compressor drives up to 75 hp, 3,600 rpm induction motors offer an obvious price advantage. Except for those ratings and above approximately 2,000 hp, the four pole, (1,800 rpm) squirrel-cage induction motor has no price competition. In these ranges, it is the least expensive electrical motor which can be purchased.

A discontinuity occurs in Figures 1 and 2 between 200 and 250 hp. The cost per horsepower goes up on all speeds of motors, both synchronous and induction as the jump is made from 200 to 250 hp. Motors up to 200 hp are built by all manufacturers according to NEMA (National Electrical Manufacturers Association) Standards[3] with production line methods. On the other hand, motors above 200 hp are manufactured to customer order and are largely custom built. This makes it particularly uneconomical to provide an extra margin of safety by oversizing arbitrarily from 200 to 250 hp. The break between 200 and 250 hp is not so severe for synchronous motors as it is for induction motors. Smaller synchronous motors are used very infrequently and, therefore, the economics of mass production cannot be applied as effectively for these motors.

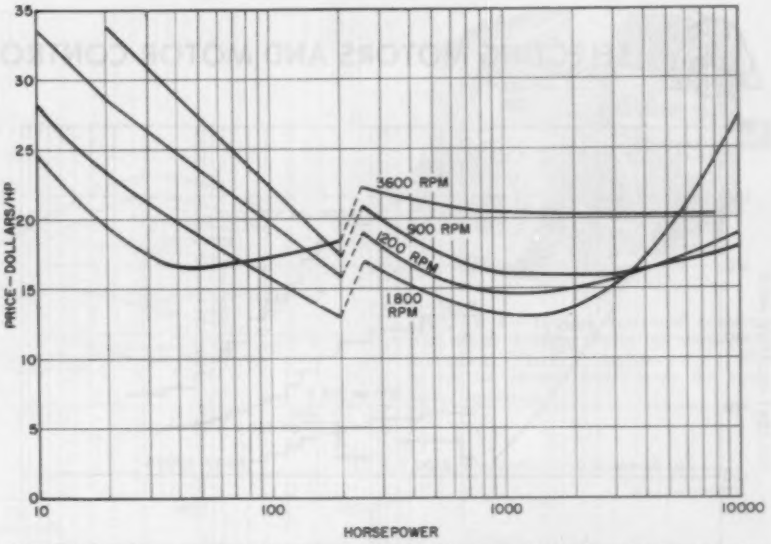

FIGURE 1—Costs are net prices to user based on 3-phase, 60-cycle squirrel cage induction standard voltages and open, drip-proof enclosures. Sudden jump at 200 hp is where production line methods stop and custom building starts.

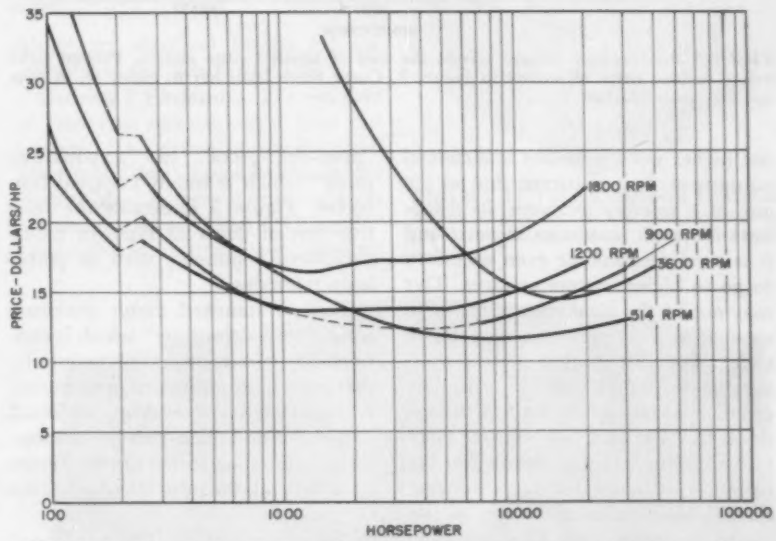

FIGURE 2—Price is for 3-phase, 60-cycle synchronous motors with open enclosures operated at standard volts and unity power factor.

Voltage. Figures 3 and 4 show the effect of specified voltage on the cost of motors. Below 200 hp, the least expensive motors are low voltage (less than 600 volts). Above 200 hp, 2,300 volts can be considered standard. Up to 1,000 hp, 440 and 550 volt motors can be obtained for the same price. As the motors become larger, more space is available for insulation and it becomes economically practical to

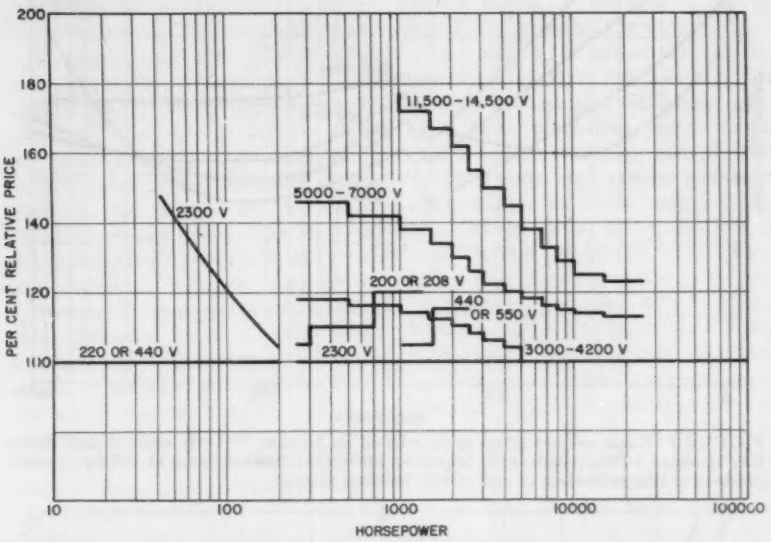

FIGURE 3—Specified voltage affects the cost of squirrel cage motors. Percent price refers to base price of motors in Figure 1. Curve reads from left to right; so, at step, use first value reached.

use higher voltage motors and control equipment. It is apparent that as the size of a refinery increases, its distribution system must also increase and it is then desirable or even necessary to go to higher system voltages. This may not be the ideal voltage for large motors so a compromise may be in order. For distribution system voltages above 5,000 volts, it is usually economical to supply transformation down to 2,400 or 4,160 volts for large motor power sources. Below 200 hp, motors cost more for high voltages since higher voltages means an increase in motor size. It is generally found that most motors below 200 hp are best supplied at the lower standard voltages of 220 or 440 volts.

Enclosures. The selection of the proper enclosure for refinery service motors is important since the type of enclosure has a considerable effect on cost. Corrosion and hazardous atmosphere problems encountered often dictate the degree of protection needed to make sure that maintenance is not excessive and expensive shutdowns do not occur. The corrosive and hazardous conditions vary between refineries and within a refinery. Consequently, no single type of motor enclosure will suffice for all applications. The applicable enclosures vary all the way from standard "open-drip-proof" to "explosion-proof" which is totally enclosed fan-cooled. Figure 5 illustrates the relative cost of different types of motor enclosures commonly used in petroleum refineries.

Today's standard motor enclosure is the "open-drip-proof" which is considerably better protected externally than yesterday's standard open motor. It is protected against dropping liquid or dirt but not against air-borne moisture, dust, or corrosive fumes. Figure 6, a typical modern standard 3-hp motor, illustrates the high degree of protection provided in this so-called open motor. Construction of this type for large squirrel-cage, wound-rotor, and synchronous motors is shown in Figure 7. On Figure 5, the "open-drip-proof" motor price is shown as the 100 percent or the base figure.

The next degree of protection above "open-drip-proof" is "Weather-Protected, Type I" which is "an open machine with its ventilating passages so constructed as to minimize the entrance of rain, snow, and air-borne particles to the electric parts."[3] All openings are screened. A few years ago, this type of motor could not have been used outdoors because the insulation available could not withstand moisture and the other deteriorating effects found in most outdoor applications. With today's improved insulation on both small and large motors, it is entirely possible to use these motors outdoors in many applications and expect good service and satisfactory life. This type is particularly applicable in outdoor applications where motor failure will not result in costly shutdowns or a disruption of operations. It is available on squirrel-cage, wound-rotor, and synchronous motors from 250 to 7,000 hp.

Where a higher degree of protection and longer life are desired, "Weather-Protected, Type II" motors illustrated in Figure 8 are recommended. Type II motors are equipped with extensive baffling of the venti-

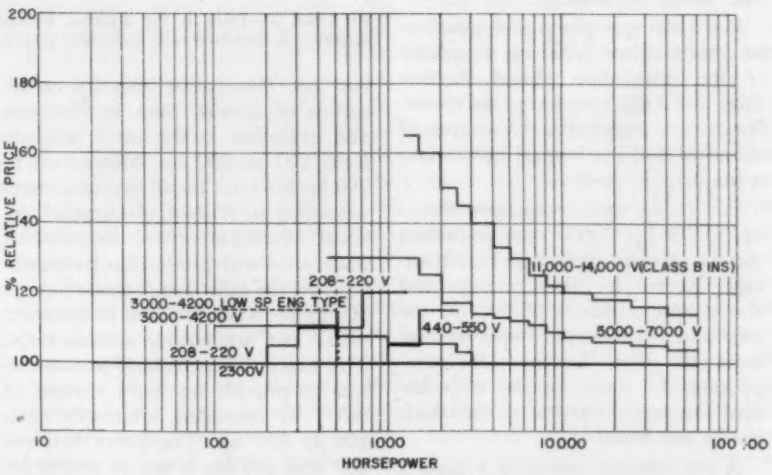

FIGURE 4—Percent price refers to base price of synchronous motors in Figure 2.

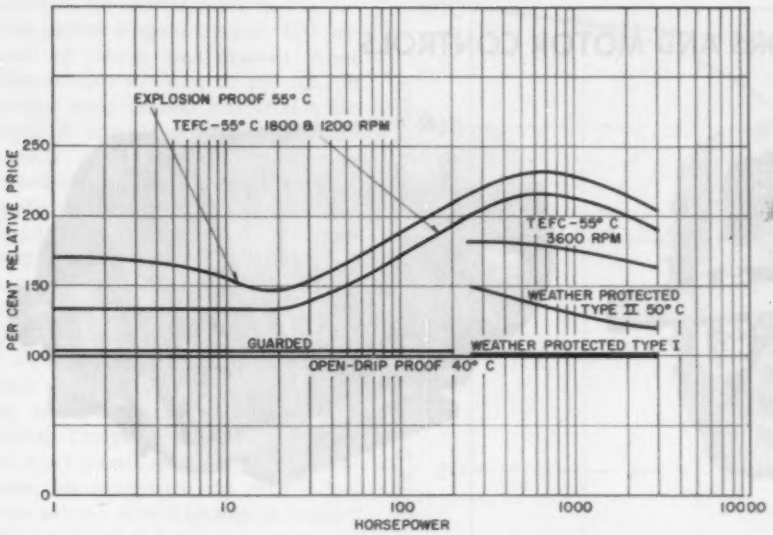

FIGURE 5—After obtaining the base price from Figures 1 and 2 and applying voltage additions from Figures 3 and 4, the percent addition for various enclosures may be found using these curves.

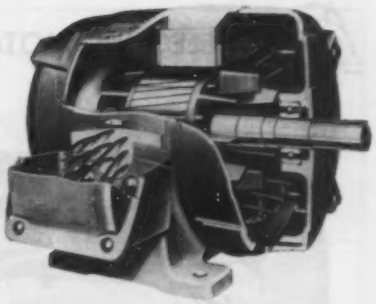

FIGURE 6—Typical dripproof construction offers a high degree of mechanical protection. Guarded construction is similar except for screens added over the ventilating openings.

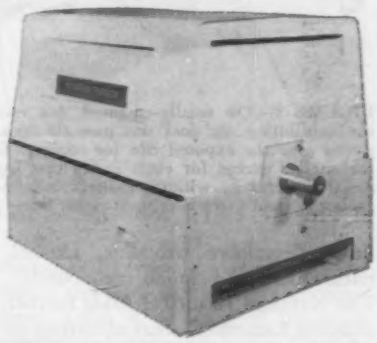

FIGURE 7—Today's improved insulation makes it possible to use this "open-drip proof, weather-protected Type 1" motor outdoors.

lating system so that the air must turn at least three 90-degree corners before entering the active motor parts. It is also constructed so that rain, snow, and dirt carried by driving winds will be blown through the motor without entering the active parts. This enclosure is most applicable where conditions are more severe or where the motor must be more reliable than that provided by the Type I enclosures. This is the case where spare power is not available for critical drives, where motors must be applied in severe weather areas, or where shutting down for repairs would result in excessive lost-production time. "Weather-Protected, Type II" construction is not applicable on motors below 250 hp.

"Totally-enclosed, fan-cooled (TEFC) motors are the obvious choice for severe applications below 250 hp. They are less expensive than "Weather-Protected, Type II" motors (below 250 hp) and provide a higher degree of protection. TEFC motors are equipped with an air-to-air heat exchanger, as shown in Figure 9, such that breathing is the only way external air ever gets inside. Except for some very special types such as "Inert Gas Filled," the "Totally-Enclosed, Fan-Cooled" motor offers the highest degree of protection against moisture, corrosive vapors, dust, and dirt. This construction is available on all sizes and type of motors except for the very small "Non-Ventilated" motors which are identical except for the omission of the ventilating fans.

Division 1 Enclosures. For the sake of clarity in this subject, a brief discussion of a portion of the National Electrical Code[2] classification is desirable. Most refinery hazardous areas are designated as "Class I, Group D" (atmospheres containing gasoline,

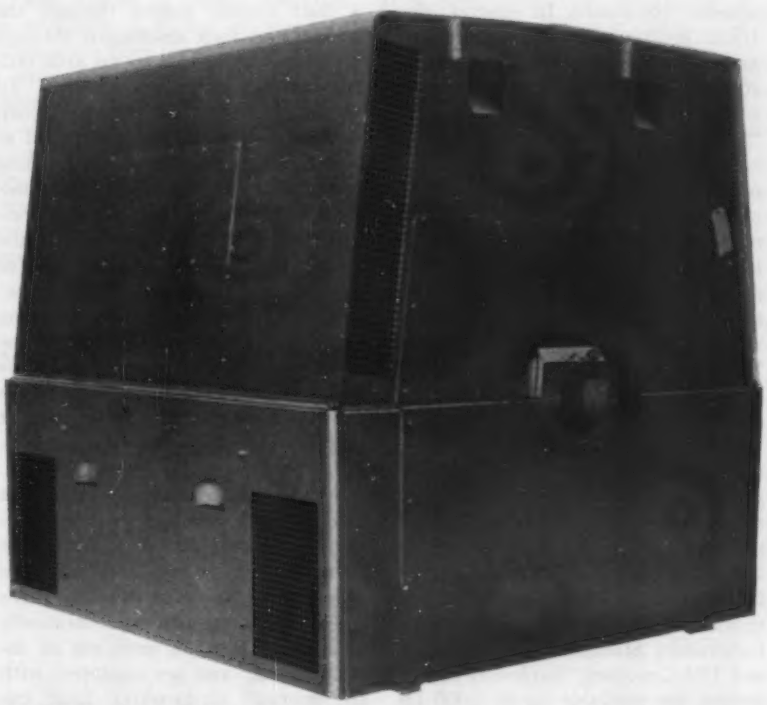

FIGURE 8—For a higher degree of protection and longer life, use the "weather-protected, Type 2" motor.

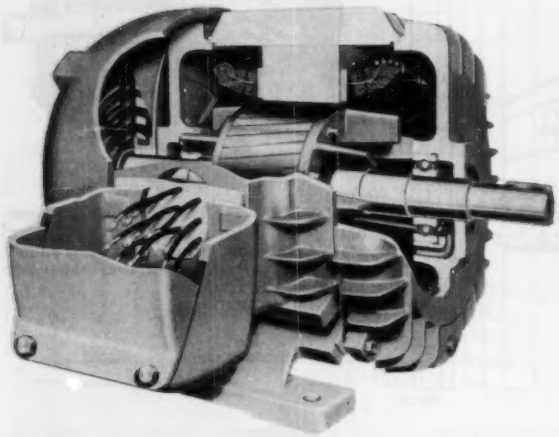

FIGURE 9—On totally-enclosed, fan cooled (TEFC) motors, the ventilating air does not pass through the active parts but passes over the exposed ribs for cooling. Explosion-proof motors are similar except for extra heavy cast iron conduit boxes with metal-to-metal fit without gaskets, longer, closer tolerances on rabbet fits and extra long shaft collar flame paths.

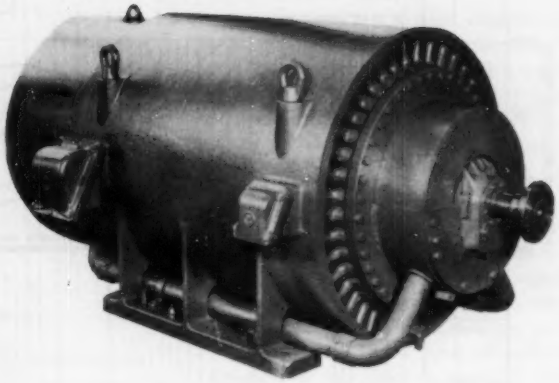

FIGURE 10—Explosion-proof, squirrel cage, induction motors are made with heavy cast construction to contain any internal explosions. Ventilating ducts are provided instead of external ribs used on smaller motors.

other petroleum products, alcohol, natural gas, and similar compounds). The National Electrical Code further classifies hazardous areas according to Division. "Division 1" locations may be hazardous under normal operating conditions. "Division 2" locations will be hazardous only under abnormal or unusual conditions. In general, electrical equipment with no normally arcing or sparking parts may be installed in "Division 2" locations in standard enclosures. For example, in "Division 2" locations, open, squirrel-cage motors may be used. Motors with open slip rings (wound rotor or synchronous) would not be permitted in either "Division 1" or "Division 2" locations. Synchronous or wound rotor motors can be applied in "Division 2" locations only if equipped with "Explosion-Proof" or "Force-Ventilated" slip ring enclosures.

The most common type of motor enclosure for "Division 1" areas is "Explosion-Proof." These enclosures can withstand an internal explosion without igniting an inflammable mixture outside of the motor. These motors are "Totally-Enclosed, Fan-Cooled" except that they are usually larger, heavier, and more carefully machined (to meet Underwriter's Laboratory Standards[4]) than standard TEFC motors. "Explosion-Proof" motors are available up to 3,000 hp at 3,600 rpm, 2,500 hp at 1,800 rpm, or 1,500 hp at 1,200 rpm; see Figure 10. Only squirrel-cage induction motors are available with this type of construction.

Force-ventilated motors are suitable for hazardous locations and are available in any type or size of motor. Safe air should be brought in through a duct system, passed through the motor, and then discharged through another duct system to an area outside of the hazardous location. To obtain the safety desired, the ventilating ducts should be pressurized at all times when the motor is running to prevent the entrance of contaminated air into the duct system. Pressurizing fans on the inlet side of the duct system should be provided for this purpose along with auxiliary relays to insure an adequate purging time of the air system before the motor is started. This type of motor has not been used extensively in refinery service since an extensive duct and ventilating system would ordinarily be required.

Inert gas-filled motors can also be used in refineries but their applications are also limited. They have tightly fitted covers and oil seals around the shaft to minimize gas leakage. The motors are continually pressurized with an inert gas or instrument air and are equipped with an internal air-to-water heat exchanger. Inert gas-filled motors are suitable for any hazardous location. They require a considerable amount of auxiliaries such as cooling water, gas pressurizing system, and control accessories for motor protection and safety. These motors would be most applicable in petrochemical operations in areas classified Groups A, B, or C.

Torque and Inrush. Figure 11 gives the speed torque curves for NEMA Design B and D motors. NEMA Design B motors have normal starting torque and low slip, and are suitable for most general purpose constant-speed applications such as pumps, fans, blowers, compressors, conveyors, or machine tools. NEMA Design D motors have high slip and high starting torque and are designed to meet the requirements of high accelerating duty or high inertia loads. Very few applications for NEMA Design D motors will be found in petroleum refineries. These classifications apply to squirrel-cage induction motors up to 200 hp. Above 200 hp, the torque requirements are generally fitted to the specific application. Figure 11 is not labeled in percent torque since the specific values of torque will depend on the speed and hp rating of motor involved. Table 1 gives locked-rotor and breakdown torque values applicable to Figure 11.

The locked rotor or starting inrush

currents for most squirrel-cage induction motors is approximately 600 percent of motor-rated current. From approximately 10 hp to 200 hp, the locked rotor current for NEMA Designs B and D motors is approximately 15 amperes per horsepower based on 220 volts, three phase. Generally, motors above 250 hp will not have as consistent locked rotor currents as motors in the NEMA size range (below 200 hp). However, for estimating purposes, a figure of 600 percent inrush may be used.

Synchronous motors are available with a great variety of starting, pull-in, and pull-out torque, and power factor. Therefore, the starting current of synchronous motors will have considerably more variation than induction motors. It will be seen in Table 2 that a starting kva as a percentage of normal running kva for synchronous motors may be as little as 275 percent or as high as 700 percent. This table will apply to synchronous motors regardless of power factor. The 80 percent leading power factor motors have normal running currents 25 percent higher than 100 percent power factor motors; consequently, the starting current will be approximately 25 percent higher.

In estimating the voltage dip on the electric power system when a large motor is started, it is safe to assume that the motor starting current is purely reactive and that the system impedances also purely reactive. The actual power factor of a-c motors starting will seldom be above 30 percent so that this is a safe assumption.

Insulation. The insulation applied to electric motors has been vastly improved in recent years. Modern insulation provides a high degree of resistance to the adverse effects of voltage stress, moisture, and other airborne contaminants, and the effects of elevated temperature within the motor.

Three classes of motor insulation are available: A, B, and H. Standard temperature rises for different classes of insulation are given in Table 3. These temperature rises are all based on an ambient temperature of 40 C. For ambient temperatures higher than this, motors must be designed for a lower temperature rise so that the sum of ambient plus temperature rise does not exceed the figure for the normal motor design. In some cases, where elevated ambients are encountered, Class B or Class H insulated motors are less expensive than Class A.

There are occasions where ambient temperatures may be considerably below 40 C for long periods of time. It is possible to take advantage of these low temperatures in emergencies by operating motors above their rating. Figure 12 shows the estimated variation of allowable *electrical* load with ambient temperature. This is estimated information and should be used only as a rough guide in cases of emergency. On machines with indicating temperature detectors, temperature can be watched carefully

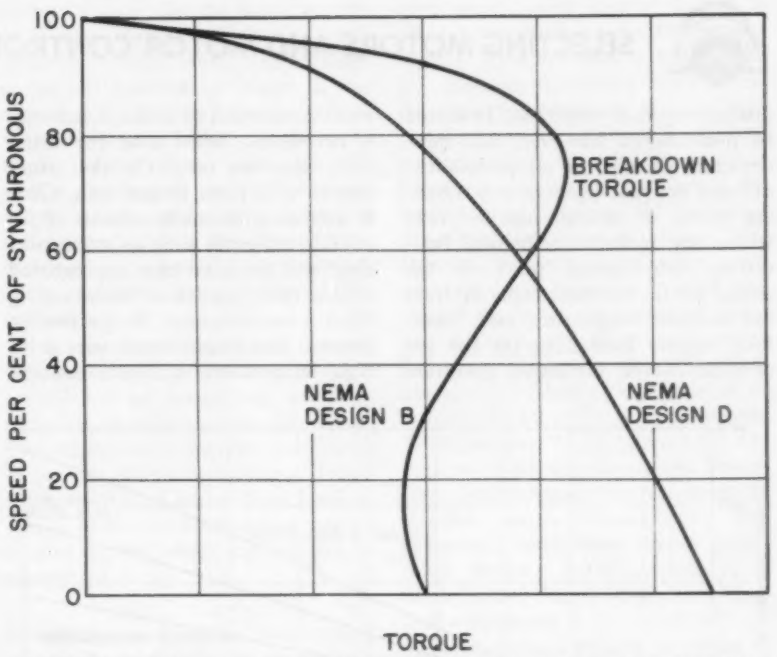

FIGURE 11—For torque values applicable to various motor ratings, refer to TABLE 1.

TABLE 1—Squirrel-Cage Motors

Speed Horsepower	LOCKED ROTOR TORQUE				BREAKDOWN TURQUE			
	3600	1800	1200	900	3600	1800	1200	900
½	...	...	...	150	...	...	...	250
¾	...	...	175	150	...	275	275	250
1	...	275	175	150	...	300	275	250
1½	175	265	175	150	275	300	275	250
2	175	250	175	150	250	275	250	225
3	175	250	175	150	250	275	250	225
5	150	185	160	130	225	225	225	225
7½	150	175	150	125	215	215	215	215
10	150	175	150	125	200	200	200	200
15	150	165	140	125	200	200	200	200
20	150	150	135	125	200	200	200	200
25	150	150	135	125	200	200	200	200
30	150	150	135	125	200	200	200	200
40	135	150	135	125	200	200	200	200
50	125	150	135	125	200	200	200	200
60	125	150	135	125	200	200	200	200
75	110	150	135	125	200	200	200	200
100	110	125	125	125	200	200	200	200
125	100	110	125	125	200	200	200	200
150	100	100	125	125	200	200	200	200
200	100	100	125	125	200	200	200	200

TABLE 2—Synchronous Motors

TORQUES			Starting KVA
Starting	Pull-In	Pull-Out	
LOW SPEED (450 RPM AND BELOW)			
40- 50%	40- 50%	150%	275%
50%	60- 75%	150%	350%
60%	100%	150%	425%
80%	110%	150%	475%
100%	60%	150%	400%
125%	100%	150%	500%
50- 75%	65%	250-300%	400-500%
80-100%	100-110%	250%	475-500%
125-150%	100%	200-250%	500-550%
150-200%	100-125%	175-250%	550-700%
HIGH SPEED (514 RPM AND ABOVE)			
60%	50%	150-175%	300-350%
80-100%	50- 60%	150-175%	350-400%
60%	100%	150-175%	425-450%
125%	100%	150-175%	500%
50- 75%	65%	250-300%	400-500%
80-100%	100-110%	250%	475 550%
125-150%	100-110%	250%	500-550%
150-200%	100-125%	175-250%	550-700%

during overload conditions. It should be remembered, however, that these detectors do not, in all probability, indicate hot spot temperatures. Loading must, of course, also be held within the motor's mechanical limitations. Mechanical parts of the motor get no overload capacity from low ambient temperature and, therefore, impose limitations on the use of these curves. Prolonged operation under overloaded conditions even with safe winding temperature may cause premature failure of bearings, shaft, or couplings.

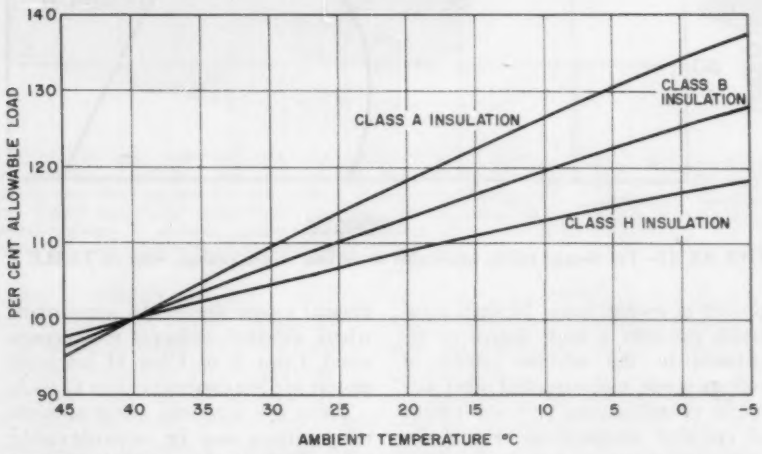

FIGURE 12—Percent allowable load refers to electrical load which should never exceed the mechanical load capabilities of the particular motor.

Under present standards the classification of insulation is based on ability to withstand a specified total operating temperature rather than according to the type of material used. The total temperature includes the ambient temperature, the measured rise in temperature, and allowances for hot spots.

Class A insulation is designed to give satisfactory insulation life with a total maximum operating copper temperature of 105 C. Typically, it consists of material such as paper, cotton fibers, organic varnishes, and similar materials. In Class A insulating systems, some inorganic materials, such as mica and fiberglass, may be used to provide the desired electrical and physical characteristics.

Class B insulation must give satisfactory operating life for a total operating temperature of 130 C. A small proportion of Class A material is permissible when used for structural purposes only. On the larger motors with form wound coils, Class B insulation normally consists of inorganic materials such as mica splittings and fiberglass tape impregnated with a resin capable of withstanding Class B temperatures. On the smaller motors, with mush-wound wire coils, high temperature synthetic enamels are used on the wire and inorganic materials are used for most of the ground and phase insulation.

Class H insulation consists of inorganic materials and silicone resins or rubbers capable of withstanding a total temperature of 180 C. For comparable temperature rises (40 degrees for A, 60 degrees for B, 110 degrees for H) approximately the same insulation life should be expected from motors regardless of the type of insulation specified. There is a feeling among some engineers that the 110 degrees rise for Class H is more conservative than Class A and B rises; this, however, has not been verified.

The major advantage of Class B and Class H insulation is that it permits a motor to be built on a smaller frame size than would be possible with Class A insulation. For example, the maximum rating of explosion-proof motors has been increased considerably without increasing frame size. Explosion-proof motors must be large and heavy to withstand internal explosions, and therefore high temperature insulation permits large reductions in space requirements and weight.

There is no price addition for Class B insulation on motors over that of a motor with Class A insulation if the temperature rise is 20 degrees higher than the Class A temperature rating. Class H (silicone) insulation does command a premium price even with the temperature rise indicated in Table 3. Consequently, Class H insulation is not commonly supplied, except where the space and weight requirements are severe.

Most of the temperature rises given in Table 3 are by thermometer measurement outside the insulation. Winding resistance measurement can also be used to determine average copper temperature which is higher (5 or 10 degrees) than the temperature measured by thermometer. Synchronous motor field windings are more conveniently measured by resistance so that the field temperature rise is given by resistance (50 degrees C for Class A), and the armature winding rise by thermometer (40 degrees C for Class A).

Notice that the 80 percent power factor motors have field temperature rises 10 degrees higher than the corresponding unity power factor motor fields. Under overload conditions, the field current of a unity power factor machine is increased to maintain a power factor at 100 percent so that the armature current is at a mini-

TABLE 3—Standard Temperature Rise

CLASS OF INSULATION:	A	B	H
Open Dripp-Proof	40°C (T)	60°C (T)	100°C (T)
Splash-Proof, Weather-Protected, Type II	50°C (T)	70°C (T)	115°C (T)
Totally-Enclosed, Fan-Cooled, Explosion-Proof	55°C (T)	75°C (T)	115°C (T)
Synchronous Motor Fields			
1.0 Power Factor	50°C (R)	70°C (R)	.....
.8 Power Factor	60°C (R)	80°C (R)	.....

(T) Indicates measurement by thermometer.
(R) Indicates measurement by resistance.

mum. However, if an 80 percent power factor motor is overloaded without changing field current, the power factor shifts toward 100 percent reducing the increase in armature current. For example, an 80 percent power factor synchronous motor can carry approximately 125 percent load with only 112 percent current (89 percent leading power factor) if the field current remains unchanged. The common practice, then, is to increase the field current for overloads on 100 percent power factor machines, but to leave the field current constant on 80 percent power factor motors. Therefore, 80 percent power factor machine field winding will probably never be overloaded and a higher temperature rise is permissible.

Class A insulated motors rated 40 degrees C rise, or Class B insulated motors rated 60 degree C rise (both by thermometer) have a service factor. On motors 3 hp and above, the service factor is 15 percent; this means an overload of 15 percent can be carried continuously with a safe temperature rise. Engine-type synchronous motors to drive reciprocating compressors are normally rated 50 degrees C rise by thermometer. In these cases, the load and future load are well known so there is little reason to supply 40 degrees C rise, 15 percent service factor motors. Therefore, motors for this service are normally rated 50 degrees C rise by thermometer with no continuous overload capacity.

Bearings. Up to motor sizes of 125 hp at 1,800 rpm, ball bearings are usually employed. On larger sizes, particularly above 200 hp, sleeve bearings are more common. As the size of the bearings increases, it becomes increasingly difficult and consequently more expensive to maintain the tolerances required in good ball-bearing design. In the smaller sizes, ball bearings are inexpensive and do not require the complication of oil reservoirs and oil rings. Modern ball bearings used on the smaller motors are sealed and prelubricated, lubricated for the life of the motor. This avoids the possibility of flushing dirt into the bearing with the grease, and prevents the all too common error of over-lubrication. Over-lubrication flows grease into the motor where it plugs the ventilating passages or deteriorates the insulation causing premature failure. On the larger motors it is not possible to obtain good, grease-lubricated, sealed ball bearings so an oil lubricating system is required. Also, the likelihood of failure with the large antifriction bearings is much greater than it is with the smaller bearings of this type. On the larger motors, particularly above 200 hp, sleeve bearings are the obvious choice except where the bearing must carry considerable thrust such as in vertical motors.

On very large, high-speed motors, it becomes necessary to employ flood lubrication by means of a shaft-mounted or motor-driven oil pump. Frequently, an oil reservoir is required to provide adequate cooling of lubricating oil. Often where flood lubrication is needed, a common lube system is used for the motor and the driven equipment.

Synchronous Motors. Synchronous motors have definite advantages in some applications. They are the obvious choice to drive large, low-speed, reciprocating compressors and similar equipment requiring motor speeds below 600 rpm. They are also useful and desirable on many large, high-speed drives. Typical applications of this type are geared, high-speed (above 3,600 rpm), centrifugal compressor drives of several thousand hp. As indicated elsewhere in this article, synchronous motors are applicable as direct drives for 3,600 rpm compressors and pumps above 5,000 hp.

One of the interesting characteristics of synchronous motors is their ability to provide power factor correction for the electrical system. Standard synchronous motors are available rated either 100 or 80 percent leading power factor. At 80 percent power factor, 60 percent of the motor-rated kva is delivered to the system as reactive kva for improving the system power factor. This leading KVAR increases so that at zero load with rated field current the leading KVAR is approximately 80 percent of the motor-rated kva. The unity power factor machine does not provide any leading KVAR at rated load. However, at reduced loads, with constant field current, the motor will produce some leading KVAR. At zero load, the leading KVAR will be about 30 percent of the motor-rated kva.

Because of their large size, 80 percent power factor motors cost 15 to 20 percent more than 100 percent motors. This addition is less expensive than an equivalent bank of capacitors. An advantage of using synchronous motors for power factor correction is that the reactive kva can be varied at will by adjustment of the field current. Capacitor KVAR varies directly as the square of voltage. Synchronous motors, on the other hand, generate more reactive kva as the voltage decreases (for moderate dips). For example, the 80 percent power factor synchronous motor will generate approximately 105 percent of its normal KVAR at 90 percent voltage. This compares to 81 percent for capacitors at 90 percent voltage. Therefore, synchronous motors tend to stabilize system voltage better than capacitors since they supply maximum leading KVAR when it is needed most, that is when the voltage is at a minimum.

When pullout torques in excess of 200 percent are required leading power factor motors (80 percent) should be selected. The easiest way for the design engineer to obtain high pullout torque is to provide additional field flux which causes a leading power factor. The 80 percent power factor motor is, therefore, less expensive when the pullout torque must be greater than 200 percent.

In addition to the good power factor of synchronous motors (never lagging), efficiency of synchronous motors is higher than similar induction motors. Efficiencies are shown on Table 4 for typical induction and unity power factor synchronous motors. Leading power factor synchronous motors have efficiencies approximately .5 to 1.0 percent lower.

TABLE 4—Full Load Efficiencies

HP	3600 RPM	1200 RPM	600 RPM	300 RPM
5	85.5	86.0	....	....
	....	....	....	....
20	87.5	87.5	....	....
	....	89.0*	86.5*	82.7*
100	91.5	92.0	91.0	....
	....	92.5*	91.4*	90.3*
250	93.1	92.4	91.4	....
	....	93.9*	93.4*	92.1*
1000	95.1	94.0	93.5	....
	....	95.5*	95.5*	95.5*
5000	96.0	....	....	....
	....	....	97.2*	97.3*

* Synchronous Motor Valves.

The large 2-pole, 3,600 rpm synchronous motors are similar to turbo-generators. They have forged rotors with milled slots for the field wind-

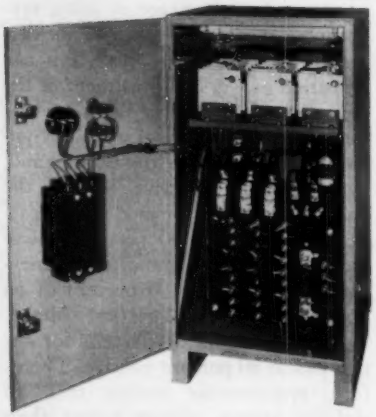

FIGURE 13—Silicon diodes mounted on square metal cooling plates have reduced the cost of rectifier exciters.

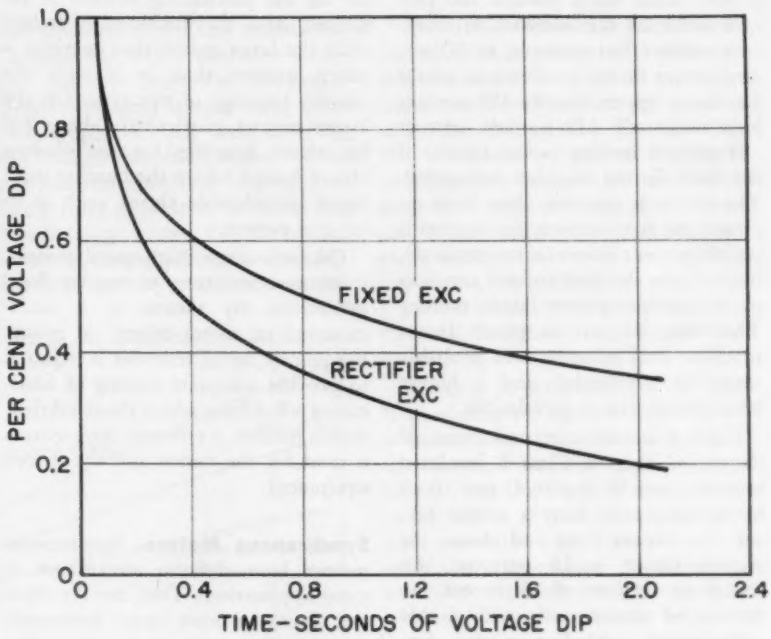

FIGURE 14—(Right) Maximum permissible voltage dip to prevent pull-out of a 2,000-hp, 100-percent P.F., 327-rpm, fully loaded, synchronous motor. Area above and to the right of the curves will result in pull-out.

ings. These motors do not usually have damper bars, and therefore have rather poor starting characteristics. For this reason, reduced voltage starting is required to limit the inrush current. Occasionally, it is desirable to use a starting motor or starting turbine to limit the electrical system disturbance. These motors are, therefore, most applicable where they can be started unloaded so that sufficient torque is available for acceleration. So far, these motors have been used very little. They are economical only for very large, high-speed drives, and the number of these applications is extremely limited. With the continual increase in high-speed compressor size, their use will become more common, and the necessary developments on starting characteristics will be made.

Excitation Systems. Ordinarily, synchronous motors fields are designed for 125 or 250 volts. Frequently there is an existing d-c system or other synchronous motors, and the voltage is chosen to match. When individual exciters are used either voltage may be used; however, it is common practice to make all field voltages the same for standardization, duplication of equipment and convenience of the maintenance personnel.

Direct-connected exciters are commonly used for all general-purpose and large high-speed synchronous motors. At low speeds (514 rpm and below) the direct-connector exciter is expensive because of its size. Motor-generator sets are widely used for low-speed synchronous motor excitation and also any time a number of motors are supplied from a single excitation bus. Where bus excitation is employed, two or more motor-generator sets are normally used to insure reliability. In the past, belted exciters were quite common for engine-type synchronous motors driving compressors; they are hardly ever used today because of the additional cost and inconvenience of adding and maintaining the pulleys and belts.

Rectifier Exciters. Rectifier exciters, Figure 13, are quite popular, today. This is particularly true because of the increased reliability, improved efficiency, reduced maintenance, and reduced cost of modern solid state rectifying devices such as silicon diodes. The rectifier circuit must be protected from high-induced voltages on pullout. A sufficient number of diodes should be connected in series and a permanent resistor should be

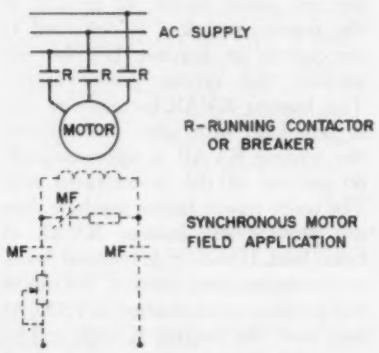

FIGURE 15—In refineries, the most common type of control for a.c. motors is full-voltage starting.

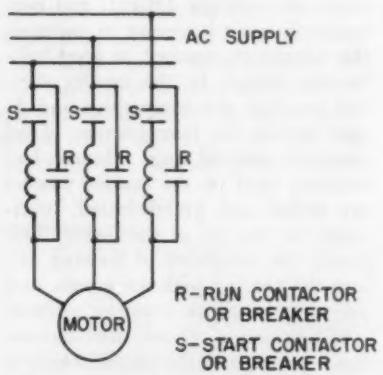

FIGURE 16—Reactor type is least expensive method of reduced voltage starting.

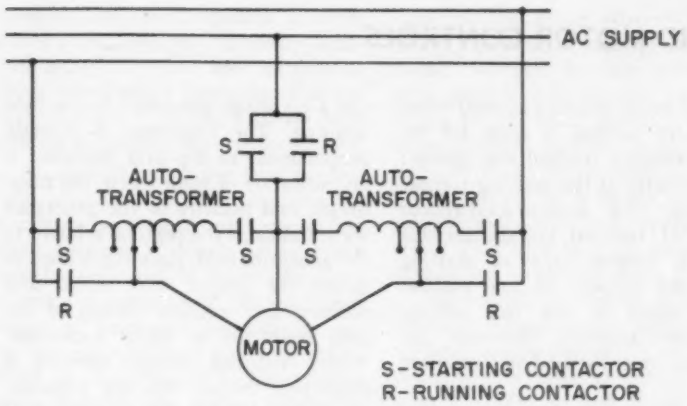

FIGURE 17—Because of transformer action in an autotransformer starter, the reduction in motor starting torque is directly proportional to the reduction in line current. This "open circuit transition" autotransformer starting is applied with a contactor type control.

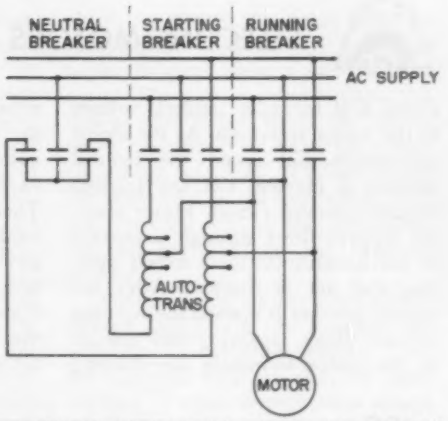

FIGURE 18—This "closed circuit transition" autotransformer is applied with a switchgear type control.

connected across the rectifier output to protect against the high surge voltages. This permanent resistor is a constant drain on the excitation system, but with the high efficiency of the available diodes, rectifier exciter efficiencies are in excess of 85 percent including the resistor losses. One disadvantage of rectifier exciters is that if the motor and rectifier are supplied from the same a-c source, sustained voltage dips reduce the pullout torque; loaded motors on the system may pull out of step. With fixed excitation (e.g. direct-connected rotating exciters) the pullout torque is directly proportional to the reduction in a-c voltage, whereas with the rectifier exciters the pullout torque will drop as the square of a-c voltage. This has not been a problem except in a few isolated instances, but it should be considered before this type of exciter is selected. Figure 14 is a typical curve showing the effect on pullout torque of rectifier versus fixed excitation. This curve cannot be used generally since the shape of the curve depends on motor torque characteristics, inertia, rated power factor, etc.

CONTROL

Starters. The most common type of control used for a-c motors in pertoleum refineries is full-voltage starting illustrated schematically in Figure 15. Here the full a-c supply line voltage is applied directly to the motor terminals so that the motor accelerates and runs with full a-c system voltage. This is the simplest and least expensive motor control. For the usual three-phase system it requires only a single, three-pole contactor or circuit breaker. Full-voltage starting is not restricted to small motors; it has been applied up to 17,000 hp. As indicated in Figure 15, full voltage starting is used for both induction and synchronous motors. A field application control panel is required for synchronous motor excitation control.

Today, all a-c motors (with the exception of very large 2-pole synchronous motors) are capable of withstanding the shocks imposed by full voltage starting. However, because of the high inrush currents (starting and accelerating), reduced voltage starting is often employed to reduce system voltage dips when large motors are started. Voltage dips must be limited where they might be sufficient to drop other motors off the line or cause them to pull out of step.

The reactor type is the least expensive method of reduced voltage starting. This scheme is shown in Figure 16. This system requires two contactors or breakers and a set of three reactors in contrast to the simple three-pole starter required for full voltage starting. The starting reactor closes first connecting power to the motor terminals through the reactors. The reactor impedance in the circuit reduces the motor terminal voltage and the starting current. As the motor approaches full speed, the running contactor closes. This shorts out the starting reactors and applies line voltage to the motor terminals. This same fundamental scheme is used for both control-type starters (contactors) and switchgear-type starters (circuit breakers) although the connections may be somewhat different. Motor voltage is reduced in direct proportion to the reduction in motor starting current. However, motor torque is proportional to the square of motor voltage so starting torque is reduced far more than starting current.

If a greater reduction in line current is required than is possible with reactor starting, autotransformer-type reduced-voltage starting can be used. Because of transformer action, the reduction in motor starting torque is directly proportional to the reduction in line current.

One type of autotransformer starter is illustrated in Figure 17. A 5-pole starting contactor and a 3-pole running contactor are required. The starting contactor is closed first and the motor accelerates on reduced voltage until it approaches running speed. The starting contactor is then opened, after which the running contactor closes. The starting and running contactors cannot be closed simultaneously because this would short out a portion of the autotransformer. This "open-circuit transition" causes a current surge when the running contactor is closed. The surge will not normally cause any trouble but starting is not as smooth as it is with reactor starting.

"Closed circuit" autotransformer starting using circuit breakers is illustrated in Figure 18. Since 5-pole breakers are not standard, the switchgear scheme uses three standard 3-pole circuit breakers which permits closed-circuit transition. "Closed-circuit" transition using contactors is similar except that a 2-pole contactor is used in place of the neutral breaker. The starting and neutral breakers are

closed first to apply reduced voltage to the motor terminals. As the motor approaches full speed the neutral breaker is opened, but the starting breaker remains closed. Motor starting current flows through a portion of the autotransformers which saturate and act as reactors. After the neutral breaker is opened the running breaker closes, applying full voltage to the motor terminals, the starting breaker opens and the sequence is complete.

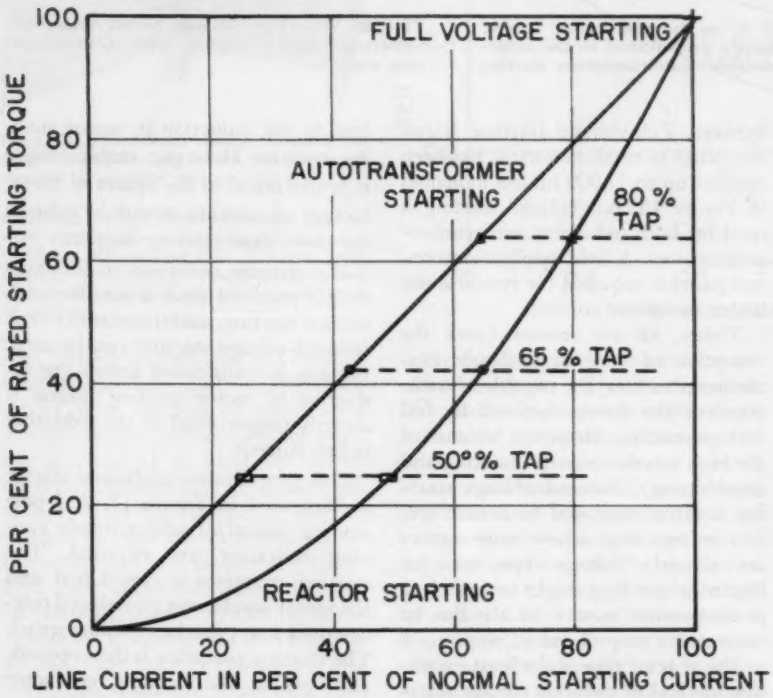

FIGURE 19—Three methods of starting are compared when starting torque is plotted against line starting current.

Figure 19 compares the different starting methods with respect to line current and torque. Where 100 percent of the motor rated starting torque is required, the only starting method that can be used is full voltage. The starting current for full voltage starting is shown as 100 percent. If no more than 64 percent of the motor-rated starting torque is required, the 80 percent tap can be used for either of the reduced voltage schemes. As illustrated, the reactor-starting current will be 80 percent; the autotransformer-starting current only 64 percent. Torque varies as the square of motor starting current when the reactor method is used; for the autotransformer method line current varies directly as the starting torque. Therefore, the autotransformer method of reduced voltage starting gives the largest value of starting torque per ampere of line current drawn (equal to the full voltage torque per ampere). However, the autotransformer method requires more equipment making it considerably more expensive.

Except for the addition of the synchronous motor field application control panel, control schemes are identical for both synchronous and squirrel-cage motors. Excitation is not applied to synchronous motors until they reach approximately 95 percent speed; the exact speed at which excitation is applied depends on the motor and load characteristics. In addition to the proper speed, the field current should be applied when the field poles are in proper space relationship to the rotating magnetic field created by the armature. Both the speed and position are indicated by the a-c voltage generated in the field winding. The frequency is directly proportional to slip and therefore is an indication of rotor speed; the magnitude and polarity of the generated wave indicates the position relative to the armature field. Relaying is used to detect the proper rotor speed and position and initiates closing of the field contactor to apply excitation. Where reduced voltage starting is employed, the a-c starting sequence is completed before the application of field current.

The schematic illustrations of the various control schemes are intended only to illustrate the basic principals. Fuses or circuit breakers are usually connected ahead of the contactors to provide short circuit protection for the motor and leads. Standard contactors will only interrupt fault currents up to ten times their continuous current rating. Usually, the potential fault current is considerably higher than this so fuses or circuit breakers are required for safety and protection. They may be mounted in the same enclosure with the contactor, or separately.

Motor Protection. Short circuit protection is essential to prevent destruction of the motor and to limit disturbances to the rest of the electrical system. This protection is provided either by fuses or circuit breakers. Short circuit protection must be set above the normal motor starting inrush current. It is provided by fast fuse blowing characteristics for these high currents or by instantaneous trip attachments or instantaneous relays if breakers are used.

Some type of overload protection is provided to prevent insulation burn outs. Thermal relays are generally used in which the relay heating is a function of motor current. The relay current-temperature characteristics are matched as closely as possible to the motor heating characteristics. For small motors, a single thermal overcurrent relay is used to provide both starting and running protection. In large a-c motors, the starting and running heating characteristics are considerably different. Under starting conditions, the most vulnerable part of the motor is the rotor, but while

running the stator winding is more likely to be damaged. Therefore, separate relays are often used to provide these two distinct functions. The use of two relays is standard on the high voltage switchgear type motor control.

Another form of overload protection frequently provided operates directly on winding temperature rather than current. Winding Temperature can be measured by bimetallic thermostats in contact with the stator end turns or resistance temperature detectors (temperature sensitive, resistance elements placed in the winding slots between the coils). Resistance temperature detectors are applied only on the larger motors with form wound coils. They operate into a bridge circuit for relaying or temperature indication. Thermostats, when used, operate electrical contacts directly. This contact can then be used for shutdown or as a warning device. Electrical insulation also acts as thermal insulation so temperature detectors of either type lag the actual copper temperature. This type of protection, therefore, will not detect severe overloads in time to protect the motor insulation. They are, therefore, only a supplement to, but not a substitute for, normal motor overcurrent relays.

When sustained power failures occur, it is necessary to remove motors from the line and start them sequentially when power returns. Most electrical systems could not withstand the combined motor inrush current of all the motors starting simultaneously. Personnel safety is also involved since it is not safe to have motors starting indiscriminately after a sustained power outage. Undervoltage protection provides these functions. In contactor-type control, instantaneous undervoltage protection is inherent since the contactor will drop out as soon as the voltage drops more than 20 or 30 percent. To override short voltage dips an auxiliary relay may be used to delay the opening of the control circuit. The contactor will then reclose if voltage is re-established quickly. Where circuit breakers are used, undervoltage relays must be provided since circuit breakers are mechanically latched and require a positive tripping signal.

Unbalanced voltages on the power system, such as single phase, can cause severe rotor overheating, particularly in large, low-slip squirrel-cage motors. Phase current balance relays can prevent damage from this cause. Voltage balance cannot be used since motors operate as a generator for the open phase. A current balance relay for each motor is recommended since the unbalance caused by one motor of a group operating single-phase will not operate the relay. This type of protection is recommended on motors above 1,500 hp.

Differential protection is applied to detect internal motor faults quickly to limit motor damage. Cost of this protection is justified only on large motors (2,000 hp and above) where its cost may be saved many times over in the event of trouble. To apply differential relays, both ends of all three windings must be brought out of the motor. The current entering each winding is compared to the current leaving it, thus internal faults are detected quickly. Because the function of differential relays is to limit rather than prevent damage, their application is limited to large expensive motors where repairs or downtime are expensive.

Lightning and switching surges have caused much motor damage. The insulation level of motors is below that of many other types of apparatus such as transformers, switchgear, cables, etc. Because of this, the system lightning arrestors will not protect the motors adequately. Special surge protection equipment is often needed, particularly for large motors connected to high-voltage overhead distribution systems subject to lightning strokes. Surge protection consists of a special low spark-over and low discharge voltage arrestors in parallel with a capacitor. The capacitor slopes off the wave front to reduce the motor winding turn-to-turn voltage and the arrestor limits the voltage rise to a safe value. This equipment is connected at the motor terminals or mounted in the control. To give maximum protection, it should be mounted as close to the motor terminals as possible.

Synchronous Motor Protection. The types of protection previously discussed apply to both induction and synchronous motors. Synchronous motors also require additional protection because of their field and damper windings.

If a synchronous motor has load torques imposed on it sufficient to pull it out of step (drop below synchronous speed) the fields must be de-energized immediately, otherwise large transient torques and currents occur. The pullout relay initiates this action and either shuts the motor down completely or starts the resynchronizing sequence. Pullout relays are connected in the field circuit and are sensitive only to the alternating current generated in the field on pullout.

Damper windings on synchronous motors are similar to squirrel-cage windings on induction motors. They are designed, however, only for starting and to serve as oscillation dampers. To prevent damper winding overheating, a thermal relay is used which operates on the induced a-c field current during the starting period.

Field failure relays, operating on d-c field current can be used to detect loss of field current before the motor actually pulls out of step. In other words, field failure relay anticipates pullouts caused by loss of field current. This minimizes the transient currents and torques of pullout.

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About the Author

Carl R. Olson is a senior engineer in the Petroleum and Chemical section, Westinghouse Electric Corp., Pittsburgh. His major activity is the application of all types of electrical equipment to the petroleum refining industry. He received a B.S. degree in electrical engineering from Carnegie Institute of Technology in 1943, and joined Westinghouse in 1946 after military service. He received his M.S. degree in electrical engineering in 1954 from the University of Pittsburgh, and is a registered professional engineer in Pennsylvania. Olson is the author of several published articles in the petroleum field.

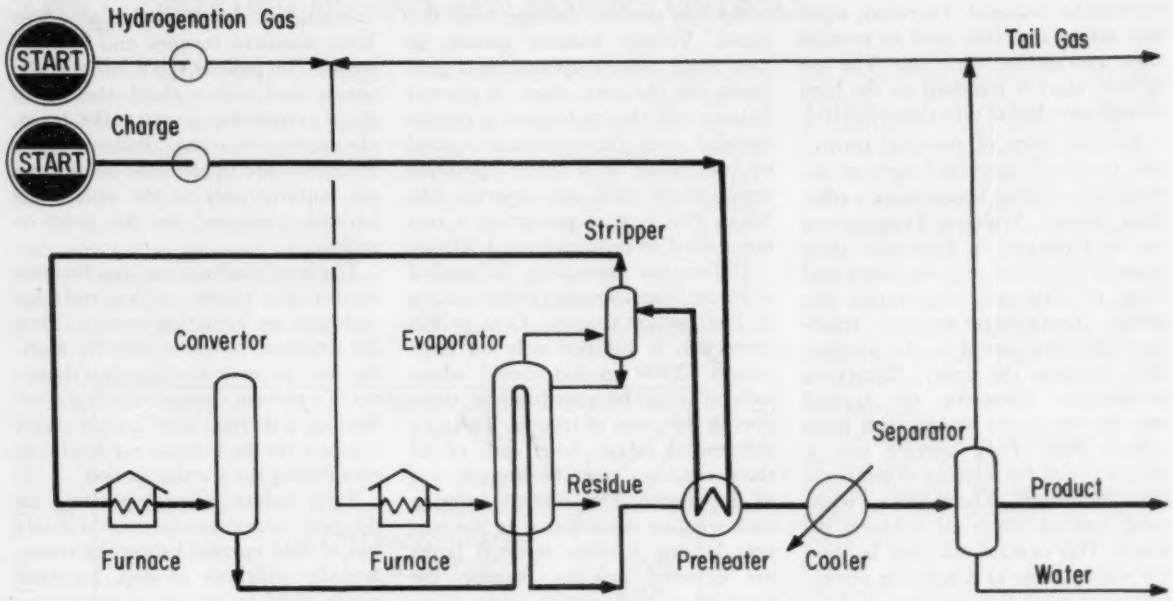

FIGURE 1—Less loss and greater quality given by this process.

New Treating Process in Pilot Stage

Hydrogen treating gets a boost from this pilot plant built for the British Coal Tar Research Association in England.

Leo Walter
Consulting Engineer, Painswick, England

WORK AT the British Coal Tar Research Association has produced a new process for treating crude naphthas and other hydrocarbons. By agreement with the association, a pilot plant was built at the Thorncliffe Works, near Sheffield, England, by Newton Chambers & Co., Ltd. They acquired world rights for the process which produces water-white color stable and sweet-smelling products.

The process uses hydrogen-rich gases from any suitable source. Among advantages claimed are: (1) an increased yield of motor fuel with a normal average loss of only 1 percent in comparison with the 5 to 15 percent encountered when washing with concentrated sulphuric acid; (2) greater purity of the product compared with conventional methods; and (3) no costly and difficult disposal of "acid tar." The new process preferentially hydrogenates sulphur compounds, gum-forming and color-forming olefines and other bodies.

The flow diagram shows crude charge pumped from storage to the plant through a preheater and an evaporator. The hydrogenation gas is compressed from its source, preheated, and introduced into the evaporator along with the charge.

Conditions in the evaporator are carefully controlled to enable a residue fraction to be removed as a liquid. The gas stream, now enriched with the fraction of the charge to be hydrorefined is then heated in another furnace to the desired reaction temperature and introduced into the converter which contains a specific catalyst. The heat content of the gas and refined vapors is utilized in the evaporator and preheater before final cooling in the condenser.

Whether the hydrogenation gas be hydrogen, straight coal gas, or modified forms of the latter, it is generally more economic to recycle the greater proportion of the tail gas, after separation from the condensate. The plant will generally be designed to work at a pressure of the order of 450 psi and at temperatures around 750 F. When desulfurization is to be carried out using hydrogen, it is claimed that the refining can be carried out at much lower pressures. ##

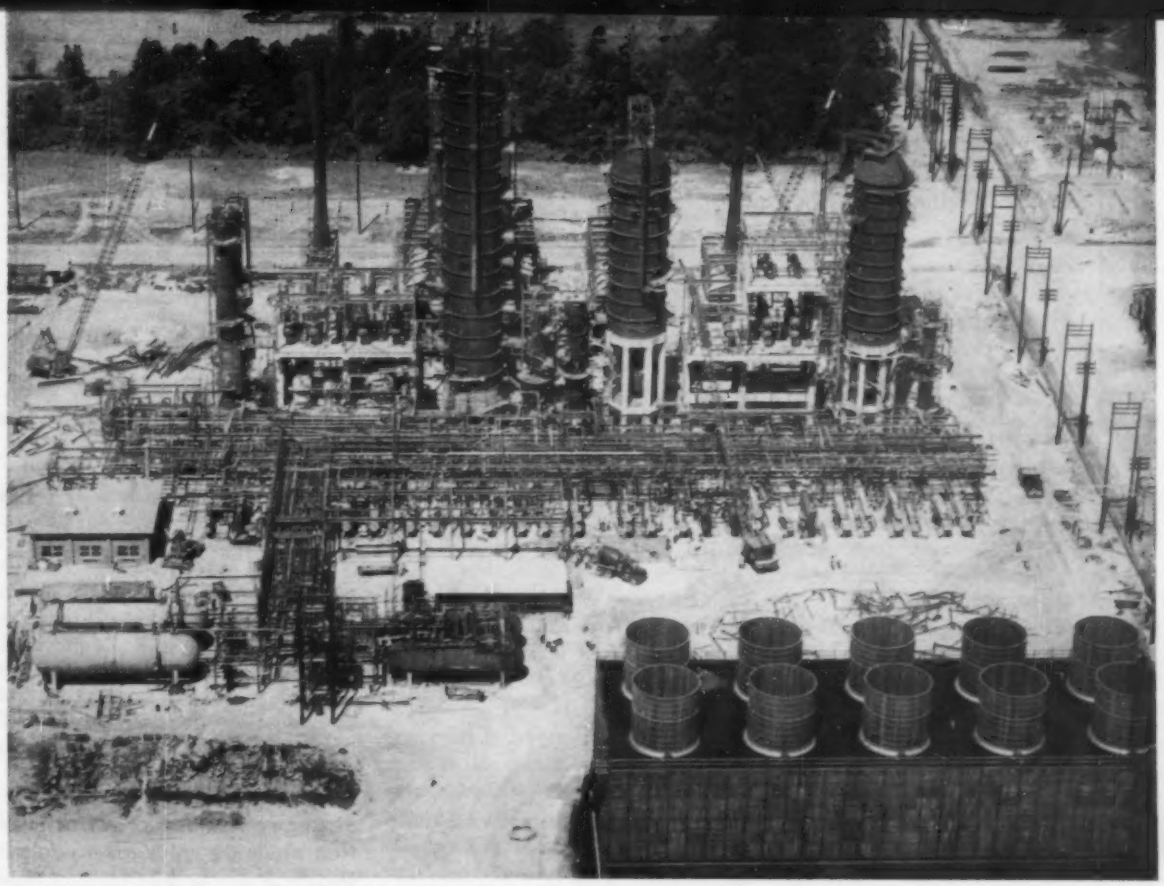

FIGURE 1—This 100,000-bpd unit replaces seven smaller ones.

Three Stage Unit Improves Crude Split

Greater product flexibility is achieved with this new three stage crude distillation unit. Now greater quantities of residual fuel oil can be upgraded to gasoline and fuel oil

G. W. Wharton and E. P. Hardin
Magnolia Petroleum Company
Beaumont, Texas

WHEN REPLACEMENT of existing crude units is being considered, as indicated by maintenance costs or other factors, expected payout on the proposed investment is one of the most important issues.

- How is a reasonable payout assured?
- What new features must be incorporated?
- Will higher productivity justify the expenditure?

These questions have been answered at the Beaumont, Texas, refinery of Magnolia Petroleum Company. As a result, a 100,000-bpd distillation unit is now under construction that will replace seven smaller units. A view of this construction is shown in Figure 1. Completion is expected in the latter part of 1958. This unit will incorporate features making it unique in the field of petroleum refining.

The unit consists of one atmospheric crude distillation tower, two vacuum towers in series for production of lubricating oil distillates, a gasoline rerun tower, and a stabilizer.

The initial study revealed a larger crude unit would result in lower maintenance costs and higher productivity as shown in Figures 2 and 3. However it was soon apparent that the higher productivity and lower maintenance of a basic replacement unit could not provide sufficient payout.

The problem, then, was to incorporate other features which would make the unit economically attractive. Four years of plant and laboratory test work and engineering study were needed to evaluate all the advantages justifying the new unit. The additional features added to the basic replacement unit were as follows:

Three Stage Unit Improves Crude Split . . .

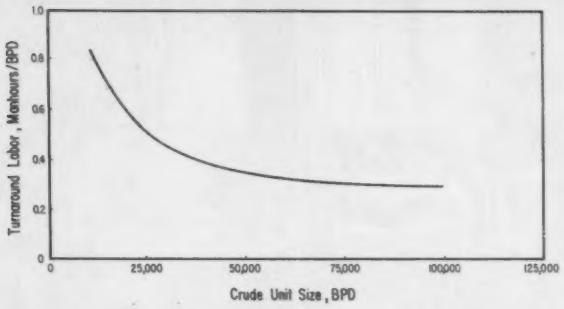

FIGURE 2—For turnarounds of larger units, a lower manpower per unit size is required.

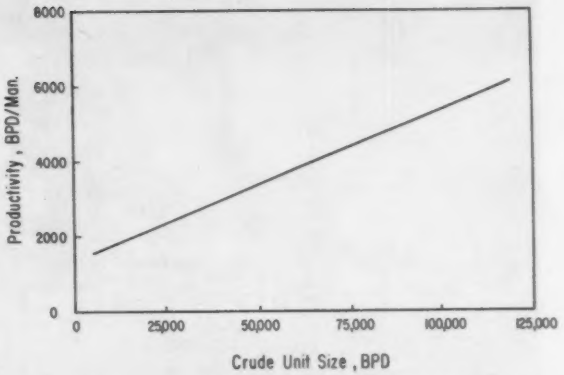

FIGURE 3—Larger units give a higher productivity per operating man.

- Added vacuum capacity,
- Improved atmospheric fractionation,
- Improved vacuum fractionation,
- Gasoline rerun and stabilization.

Brief summaries of the basic replacement unit and these additional features are presented which describe the process and economic aspects of each.

Basic Replacement Unit. A unit designed to exactly replace existing units would consist of a single 100,000-bpd atmospheric crude tower and a 16,000-bpd vacuum tower. The vacuum tower would process about half of the reduced crude. The remainder would be sent directly to residua processing for catalytic cracking feed preparation. No changes would be made to the quantity or quality of the stocks produced since towers, heaters and coolers would be sized to give only the amount of fractionating efficiency available in existing equipment. The crude tower would be sized 22 feet in diameter with 24 trays. Similarly the vacuum tower would be sized to reflect current operating conditions. This would result in a tower 16 feet in diameter with 23 trays. Such a unit would offer a number of advantages such as simplification of lines and tankage, modernization of control, focusing of engineering and supervisory efforts and a reduction in maintenance, laboratory and operating manpower. In spite of these several advantages, sufficient justification could not be found to warrant this type replacement.

Added vacuum capacity, sufficient to vacuum flash all the reduced crude from the atmospheric tower, enlarged the basic vacuum tower from 16 feet in diameter to 24 feet. Originally, part of the reduced crude was further processed on visbreaking units. However, vacuum flashing of residua before visbreaking was found to be very attractive.

The net product shift resulted in upgrading residual fuel oil to gasoline and light furnace oil. This shift is accomplished by catalytic cracking of heavy virgin gas oils previously charged to visbreaking. The revenue available from this operation was more than enough to pay for the additional investment for increased vacuum capacity.

Sharper Atmospheric fractionation within the crude tower results in greater ability to shift product yields to meet processing demands. The improvement was attained by increasing both reflux ratios and number of trays between products.

Differences in product yields were observed on various crude units in the yard. This led to a laboratory program to determine how the degree of separation affects yield of controlled products. Plant-produced distillates were recombined, and the blend was distilled in the laboratory on equipment with high fractionating efficiency. Products were obtained which maintained the same control tests as those from the plant, but permitted a shift in yields.

The results in Table 1 show that when running for a 360 F. end point gasoline in the plant, a 125 F flash kerosine was obtained as the next heaviest product. The boiling range of gasoline overlapped that of kerosine. With laboratory fractionation, on the other hand, a gap occurred between the distillations. For the same 360 F. end point, gasoline yield was increased about 3 percent by removal of gasoline boiling range material from kerosine as evidenced by the increased kerosine flash point. The yield

TABLE 1—Effect of Fractionation on Crude Tower Product Yields

	Gasoline	Kerosine	Lt. Gas Oil	Hvy. Gas Oil
I. Plant Distillation—Normal Fractionation				
Yield, Percent Crude	36.3	25.9	8.3	2.6
Flash Point, COC, F.	..	**125**	255	..
ASTM End Point, F.	**360**	550	638	..
II. Laboratory Distillation—Improved Fractionation				
(a) Maximum gasoline with same end point as now produced.				
Yield, Percent Crude	39.6	26.0	6.0	1.5
Flash Point, COC, F.	....	176	280	..
ASTM End Point, F.	**360**	550	638	..
(b) Maximum Kerosine with same flash as now produced.				
Yield, Percent Crude	27.7	37.9	6.0	1.5
Flash Point, COC, F.	....	**125**	280	..
ASTM End Point, F.	300	550	638	..

Note: Bold numbers show control tests.

of kerosine was similarly increased at the expense of gas oil. Conversely, when the kerosine fraction was produced at the minimum flash point of 125 F., gasoline yield was decreased about 9 percent below plant yields.

This flexibility allows substantial product shifts: gasoline can be maximized from crudes containing good reforming material, and kerosine production can be maintained from other crudes. This point alone is of significant economic importance and indicated a revenue more than adequate to pay out the cost of improving atmospheric fractionation. The revenue was derived from optimizing the yield of good reforming stock at the expense of poorer stock. Thus at constant reformer charge, the amount of naphthas that allow higher reforming yields are increased. Also of considerable importance is the ability to increase kerosine production during the heating oil season.

To achieve the flexibility desired, it was decided that no overlap should occur between the boiling ranges of adjacent products. Reflux requirements and number of trays between cuts were arranged to give the desired fractionation according to the Packie correlations.[1,2]

The Packie charts were checked against several operating crude towers and fairly close agreement was found between the calculated and observed degree of fractionation. In general, however, separation between lighter products was slightly better than calculated; between heavier products, it was slightly worse. The correlations indicate that by increasing reflux the number of trays may be reduced for the same degree of fractionation or vice versa. The optimum design eventually depends on the economic balance between tower diameter and height, heater and condenser duty, and utility consumption.

The final design for the atmospheric tower was obtained by expanding the tower to 23 feet in diameter, increasing heater and reflux duties, and using 48 total trays. There are in effect only 34 fractionating trays above the flash zone since six trays are used in the stripping section and several trays are devoted to heat transfer only. Crude tower performance as predicted by the Packie correlations is expected to be as shown in Table 2.

Improved vacuum fractionation between vacuum distillates was shown to result in increased yields of lubricating oils and wax. Operation of two vacuum towers in series was the most attractive way to attain the required fractionation.

Overlapping of the boiling ranges of vacuum tower products was found to be even more pronounced than those from atmospheric distillation. Concern over good separation between lubricating oil products has not been too widespread since control tests such as flash point, viscosity, and color have been used rather than distillation. Laboratory distillations were run under vacuum in order to obtain curves with which to measure fractionation.

Atmospheric residua from lubricating oil type crudes are run on vacuum towers that produce four lubricating oil distillates and a vacuum residuum. A test run was performed on the existing units to simulate the new design by shutting off two strippers and removing only two distillate products. The long residuum from this operation was then rerun on the vacuum tower to produce the other two distillates. The resulting improvement in lubricating oil distillate yield and quality during this and other similar test runs verified the two-stage vacuum system as a desirable process. The improved degree of separation is demonstrated by the reduced amount of overlap as summarized in Table 3.

Advantage of the two-stage system is derived primarily from increased reflux ratios available at the heavier product draw trays. Vapors which would be passing these trays in a single tower system (aggravating entrainment and reducing the L/V ratio) have been removed in the first tower. A lower vacuum can be maintained in a second tower flash zone, due to fewer trays, than in an equivalent single tower. This allows flashing deeper into the charge to give more overflash which in turn increases reflux ratio. Final design of the vacuum system consisted of one 24-foot tower followed by a 22-foot tower. Each tower contains 26 trays. The second tower employs a total draw-off on the lower stripper with a measured quantity pumped back under the drawoff pan for reflux to the lower trays.

Engineering studies were made to determine whether a single vacuum tower could produce the same fractionation as a two-stage system, based on similar reflux ratio times number of trays. The design employing a single, large tower was found more costly than the paired towers and the same degree of fractionation was virtually impossible to obtain between the heavier products. The best practical reflux ratio that could be obtained between products for equivalent operations are shown in Table 4.

Residuum. Plant and laboratory tests showed that operation of the lubricating oil solvent extraction units could be greatly improved by better fractionated distillates. Increasing the yield of 800 viscosity distillate (Lube D) at the expense of residua permits processing of higher viscosity residua through a residual oil unit. The heavy distillate can be processed on a distillate treater and blended with the residual oil raffinate, thereby increasing bright stock production.

Secondly due to sharper separation, the improved quality of the lubricat-

TABLE 2—Determination of Crude Tower Fractionation

Sepration	Reflux Ratio	No. of Trays	Diff. in 50% Pts., F	Packie(Gap) 5%-95% Pts., F
Gasoline-Naphtha	2.17	8	145	23
Naphtha-Kerosine	1.54	12	235	36
Kerosine-Lt. Gas Oil	1.13	8	340	40
Lt. G.O.-Hvy. Gas Oil	0.61	6	335	20

TABLE 3
Effect of Vacuum Stages on Fractionation

Product Nominal Viscosity, SUS @ 100 F	Normal One-Stage Overlap, F 95%-5% Pts.	Test Run Two-Stage Overlap, F 95%-5% Pts.
50	77	37
200	130	18
400	200	35
800	...	..

TABLE 4—Comparison of Reflux Ratio Between Products One-Stage Vs. Two-Stage Vacuum Towers

Lube Produce	Nominal Viscosity, SUS @ 100 F	One-Stage Mol/Mol	Two-Stage Mol/Mol
A	50	18.8	17.5
B	200	2.2	6.0
C	400	1.2	3.1
D	800	0.2	0.3

Three Stage Unit Improves Crude Split . . .

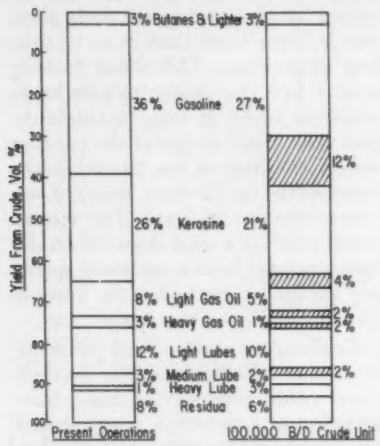

FIGURE 4—Through better fractionation, the shaded portions can be diverted to either adjoining product and still meet specifications.

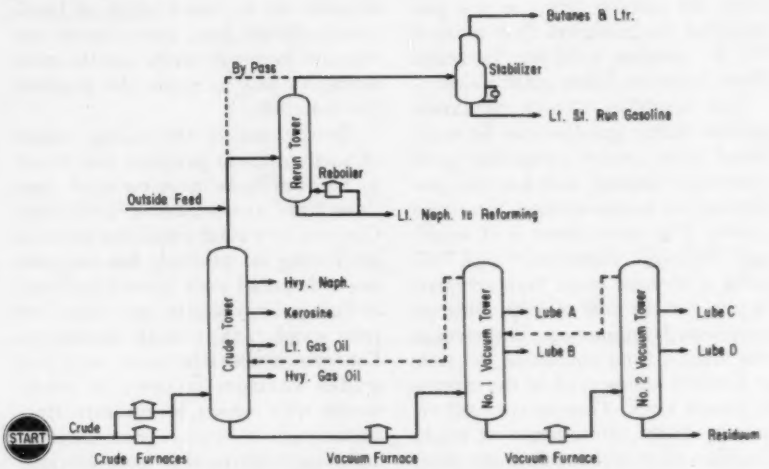

FIGURE 5—The recycle streams shown in dotted lines are redistilled into suitable products.

About the Authors

Wharton

Hardin

George W. Wharton received his B.S. degree in petroleum refining engineering from Colorado School of Mines in 1951, and that same year joined Magnolia Petroleum Co. as a process engineer in the Technical department of the company's Beaumont refinery. His previous assignments have included work on crude distillation units, gas plants, laboratory process control, applications of statistical quality control in refining, and process design of the new 100,000-bpd crude unit. He is presently a process engineer on thermal cracking units.

Edward P. Hardin received a B.S. degree in chemical engineering from Texas A. & M. in 1947. He then joined Magnolia Petroleum Co. as a process engineer in the Technical department of the Beaumont refinery. Job assignments have included process work on catalytic cracking, crude distillation, solvent extraction, solvent dewaxing, treating work in the pilot plant laboratory, and economic development work in planning and coordination. He is presently a supervisory process engineer in planning and coordination.

ing oil distillates allows higher rates on the dewaxing units. The dewaxing capacity created by the increased throughput allows an increased production of lubricating oils and wax. The revenue derived from these process improvements was sufficient to pay out the cost of improving vacuum fractionation.

A summary of product flexibility for the old and new units is shown in the bar chart in Figure 4.

Gasoline rerun and stabilization will be accomplished within the new unit. With the old equipment this was done on five rerun towers removed geographically from the crude units. In intermediate storage quantities of light hydrocarbons were lost by evaporation. With rerun and stabilization prior to storage, sufficient savings will be realized to pay out these towers. Further, the five existing towers have other potential uses in refinery operations.

Several additional features have been incorporated into the unit to insure a high streamtime efficiency, improve fractionation and increase flexibility of operations. Crude oil charge is to be heated in two parallel trains, each of which includes charge pumps, exchangers, desalter, and furnace. Maintenance on these items can be performed with little or no loss in throughput.

The unit was designed for alternate operations that permit piecemeal turnarounds. That is, only one tower and its auxiliaries need be shut down at a time. Atmospheric tower residuum can go to storage while other towers are down, and be returned and processed on the vacuum towers while the atmospheric tower is down. Operation of the rerun tower and stabilizer was made entirely independent of the other equipment by supplying them with external heat sources and alternate outside feed lines.

Gas oil streams are to be taken from the top of the vacuum towers to control flash points of the lube distillates. Each of these overhead products is to be cycled to the preceding tower for redistillation into suitable products, as shown by dotted lines on the flow diagram in Figure 5.

Surface-type condensers were used on the two vacuum towers rather than a barometric system. This closed system was designed to keep cooling water clean and minimize oil losses. Water condensate was designed for use as process water for the desalters to further prevent oil contamination of the water system.

Crude tower, rerun tower and stabilizer flow plan will allow increased operational flexibility. Among product streams that can be made under various processing schemes are light and heavy reformer naphthas, light straight run gasoline for motor fuel, jet fuel naphtha, and solvent naphtha.

LITERATURE CITED

[1] Packie, Trans. AIChE, p. 59, Vol. 37, 1941.
[2] Prater, N. H., O&GJ, p. 72, May 2, 1955.

A Check List for Plant Layout

Whether it's a refinery or petrochemical plant, these tips will help you attain maximum flexibility and compactness at a reasonable first cost

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• The process units should lie to one side of a rectangular tank farm, and the shipping facilities on another side in order to minimize the length of piping runs between process units and tankage, and between shipping facilities and tankage.

• Intermediate tanks should be located close to the process units; blending, shipping and crude tanks progressively farther out.

• Administration and service facilities should be grouped near the plant's main entrance near to the initially installed process units, so as to minimize the distance between the plants and service units such as the shops, control laboratory, storehouse, etc.

• The ultimate administration building should be an "H" shape progressively developed from a simpler form.

• Warehouse, salvage yard and shops should be close together, for obvious reasons. These should also be adjacent to a railroad spur. The firehouse should ordinarily be near the laboratory if laboratory personnel are called upon to man fire-fighting equipment.

• The changehouse should preferably be located so that personnel will have to punch the time clocks on their way in and out. It is assumed that lockers would also be provided in the individual control houses of the process units. Access to the changehouse from the outside should preferably be under the direct surveillance of the main gatekeeper in order to minimize theft. For a similar reason the parking area for night-shift employees should also be under the observation of the main gatekeeper.

• The boilers and water-treating facilities should be located in a position where a major plant fire would not be likely to cause interruption of the steam supply.

• Cooling towers should be located where water drift from the towers will not cause exterior corrosion of process equipment. Moreover, the towers should preferably be oriented crossways to the prevailing wind in order to minimize recycling of air from the discharge of one tower to the suction of an adjacent tower.

• Buffer space should be provided between the tank farm and the process units to accommodate misellaneous small tankage and other minor facilities which later may become necessary.

• Tetraethyl lead storage should be planned reasonably close to a tank-car unloading spot to minimize line washing.

• The location of effluent treating facilities will depend upon the natural terrain.

• The location of any coke pile should be such that strong winds from any direction will not create a dust nuisance.

• Hazardous tanks smaller in size than 35,000 barrels can be grouped with one-half diameter clear space between them, provided there is not more than 150,000 barrels of total tankage within any single firewall area.

• Other hazardous tanks are assigned to individual firewall areas, with a clear space of one diameter between any pair.

• All hazardous tanks of appreciable size are given a set-back at least 200 feet from the property line, from railroad tracks and fired heaters.

• Decentralization of the refinery flare system is contemplated, e.g. each major plant will have its own flare, where such is necessary.

• Decentralization of tank farm pumping equipment is also considered preferable to a central pumphouse in order to minimize damage in the event of fire.

TABLE 1—Typical Spacing Between Process Units and Related Facilities

Distance	From	To
100 Ft. (Min.)	One Process Unit	Another Process Unit
15 Ft. (Min.)	Tower Structures	Pumps
15 Ft. (Min.)	Pumps	Exchangers
50 Ft. (Min.)	Electric Substation (Pressurized)	Refinery Equipment
100 Ft.	Electric Substation (Not Pressurized)	Refinery Equipment
50 Ft.	Blowdown Facilities	Refinery Equipment
50 to 75 Ft.	Furnaces	Towers Pumps Exchangers
50 to 75 Ft.	Control Houses	Unit Structures and Furnaces
75 Ft. (Min.)	Pressure Storage Facilities	Refinery Equipment

PLOT PLAN DEVELOPMENT

• There must be adequate spacing between all pieces of equipment to avoid plot congestion after piping, valves and instruments have been added.

• Pump and compressor suction lines should be short.

• Furnace transfer lines should be short.

• Alloy lines should be short.

• Hot lines should be long enough for proper flexibility and should have enough elbows to minimize or eliminate the need for expansion joints.

• Other piping should be kept short, but only to the extent that this does not interfere with achievement of other objectives listed below.

• To minimize structural steel usage and plant equipment maintenance costs, overhead equipment should be kept to a minimum. Heat exchangers at grade should be

stacked 2-high only when using two shells in series.

- Maximum access is desired to all equipment and piping for maintenance purposes, including access for pulling furnace tubes and exchanger bundles, as well as laydown area for maintaining overhead equipment. Pumps and drivers should be removable to the shop via A-frame truck. The same is true of exchangers.
- There should be adequate access for fire-fighting purposes.
- There must be provision for fast departure of personnel from the vicinity of any particular equipment during an emergency. Hence X-bracing of structures is undesirable.
- There should be adequate access during construction.
- There should be adequate space for future expansion of both equipment and pipeways, e.g. bottleneck removal work.
- Engineering expenses should be minimized by the use of identical twin units (not mirror images) wherever possible. There should be at least 100 feet of clear space between plants to allow welding on one when the other is in operation.
- Safety rules for spacing of hazardous and non-hazardous equipment should be observed (vide: Armistead's rules).
- Equipment should be arranged in process flow sequence where possible, in order to provide for ease of operation, particularly during emergencies and when training new operators.
- Also, for good operability, we should keep related pieces of equipment together, provided this does not unduly increase cost, or unduly complicate the piping.
- Valve stems should never be located at face-level because of hazard to personnel. No piping should be at grade level in operating areas.

SPACING OF EQUIPMENT

To facilitate eventual bottleneck removal on each process unit, to reduce construction and engineering costs, to expedite scheduling of construction laborers and to minimize maintenance expense and disaster hazards, plot plans should be arranged generously. Below are listed some tentative criteria derived from a number of existing moderate-sized refinery and chemical plants which do not appear unduly congested. For large equipment sizes, the indicated spacings may be shortened somewhat.

- For fractionating columns with elevated condensers mounted on common steelwork between each pair of columns, the center-to-center spacing between the columns should usually be about 7 to 8 times the average of the two column diameters. Generally, use 15-foot column skirts to assure proper NPSH for pumps.
- Horizontal reflux accumulators should be spaced about 2 diameters apart (center-to-center).
- Large Horizontal storage vessels should be spaced about 1½ diameters apart (center-to-center) provided this in no case results in a clear space of less than 6 feet between the vessels. Not more than 4 large horizontal storage vessels should be in a single group if the contents are hazardous materials such as light hydrocarbons, or highly toxic materials.
- API storage tanks should be similarly spaced unless levee requirements allow a greater spacing (e.g. 2½ diameter c. to c.) at little or no extra cost. (See Armistead's book, "Safety in Petroleum Refining").
- Small vertical accumulators, extractors, reactors, etc. should be spaced about 3 to 4 diameters apart (center-to-center).
- Large vertical vessels and reactors should be spaced about 2½ to 3 diameters apart (center-to-center).
- Center-to-center spacing of horizontal heat exchangers should be about 2 to 2½ diameters if elevated, or about 3 to 4 diameters if near ground elevation.
- Center-to-center spacing of vertical heat exchangers should be about 2½ to 3 diameters.
- Center-to-center axis spacing of medium size horizontal pumps should be about 7 feet (4 feet for small pumps). Alternatively, there should be allowed about 5 feet of clear space between pumps (2½ feet for small pumps) exclusive of piping. Center-to-center spacing of fairly large horizontal pumps should be about 9 feet. No pumps should be located within tankfarm firewalls.
- There should be a clear space of a little more than one-half a compressor width (but 8 foot minimum) between each pair of adjacent compressors, and at the end of the compressor row. There should be a similar clearance at each end of a compressor.
- Furnaces should be spaced about 2 diameters apart (center-to-center), with at least adequate room for pulling tubes.
- The pipeway should provide about 30 percent of its space for future lines. Double-decked pipeways are satisfactory, but not triple-decked.
- Process Units should be spaced side-by-side about 1½ plant widths (clear space) from each other (average width), including pipeways as parts of their adjacent plants.
- Whole process units of moderate size should be located on a basic grid on which the access road spacing is about 200 to 250 feet center-to-center in one direction, 300 feet in the other direction.
- A centralized control-house should house as many instruments as is practical. The instrument panel length will probably be about 7 feet per million dollars of plant cost in the usual case. Space allowance should be made for a data logger and its supporting equipment.
- Preliminary plot plan studies for expediting decisions as to plant location should include generous rule-of-thumb allowances for pipeways, roads, etc. ##

About the Author

John F. McGarry has been an independent consultant and lecturer for the University of California since 1956. He received B.S. and M.S. degrees from California Institute of Technology—then served Shell Oil Co. for ten years as a process engineer. McGarry then gained six years' chemical processing experience with Shell Chemical Corp. He was with the Atomic Energy Commission's Personnel Security Board. McGarry is a registered professional engineer in California.

Applied Hydrocarbon Thermodynamics

Part 9: Generalized Exponents from Entropy Balances

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THE EXPONENTS that define the temperature and volume changes for reversible adiabatic and polytropic compression and expansion of gases were derived from heat capacity and compressibility factor relationships in the previous two installments.

Although thermodynamically correct, these exponent procedures cannot be completely generalized and were not as convenient to apply as desired. They did serve a useful purpose, however, by providing a basis for developing a correction factor for computing polytropic exponents.

This previous work will be used with entropy balances in the development of more simple and convenient exponent correlations, which are presented in this installment.

The exponents that define temperature and volume changes with a reversible and adiabatic pressure change may be found from entropy balance relationships. This method has been used to develop charts giving n′ and n, the isentropic exponents, as functions of the reduced conditions (i.e., T_r and P_r) and the ideal gas state exponent k (i.e., $C°_P/C°_V$). The adiabatic efficiency and polytropic correction, developed in Part 8, are used to extend these new correlations to nonadiabatic reversible compression and expansion. Irreversible compression and expansion are not included in the correlations given here. Irreversibility will be taken up in Part 10.

Exponent for Ideal Gas State. Plots of k versus temperature for hydrocarbons and other gases are given on Figures 9.1 and 9.2, Figure 9.1 being for hydrocarbons and 9.2 for miscellaneous other gases. These were prepared from $C_P°$ values from Tables 7.3 and 7.4. Ideal gas state exponent values from these plots are used in applying the generalized correlations, presented in this installment, to get the exponents for real gases.

Entropy Balance Equations. The *entropy balance* was one of the three methods mentioned in Part 7 for making temperature change and work calculations for isentropic compression and expansion of gases. A zero change in the total entropy of the gas for the complete path is the required condition for a reversible and adiabatic compression or expansion. The entropy of the gas will change if there is a reversible addition or removal of heat or if there is irreversibility due to friction.

From the entropy relationships in a previous installment, i.e., Equations 7.2, 7.3, and 7.4, the following expression is obtained for any path:

$$C_P°_{mean} \ln \frac{T_2}{T_1} = R \ln \frac{P_2}{P_1} - \Delta(\Delta S') + \Delta S \qquad (9.1)$$

where $C_P°_{mean}$ = ideal gas state heat capacity, a function of temperature only for each hydrocarbon

$$= \frac{\int_{T_1}^{T_2} C_P° \frac{dT}{T}}{\ln \frac{T_2}{T_1}}$$

$\Delta S'$ = residual entropy (nonideal correction) and a function of reduced temperature and pressure (values of $\Delta S'$ are given in Table 7.5 and on Figure 9.3).

ΔS = entropy change for path ($\Delta S = 0$ for isentropic compression and expansion).

Equation 9.1 applies to any path, isentropic or polytropic, reversible or irreversible. This is demonstrated in Tables 9.1 and 9.2, which will be discussed later.

The main utility of this entropy balance relationship is to find gases, as defined by the $C_P°_{mean}$ values, that satisfy the assumed generalized terminal conditions. This is done by back-calculating $C_P°_{mean}$. Numerical examples, given later in Table 9.3, will illustrate this procedure. Application to back-calculate $C_P°_{mean}$ for polytropic paths requires knowing or assuming the value of ΔS. This is not as easy as assuming $\Delta S = 0$.

The isentropic form of Equation 9.1 that will be used in developing a generalized isentropic exponent correlation is

$$C_P°_{mean} \ln \frac{T_2}{T_1} = R \ln \frac{P_2}{P_1} - \Delta(\Delta S') \qquad (9.2)$$

Equations 9.1 and 9.2 differ by the ΔS term. The magnitude and sign of this ΔS term indicates the polytropic nature of reversible paths. (For irreversible paths, the entropy increases, i.e., $\Delta S > 0$.)

The residual entropy difference, $\Delta(\Delta S')$, is the term in Equation 9.2 that makes the temperature change exponent different from that of the ideal gas, i.e., the heat capacity ratio, $k = C_P°/C_v°$. If this residual entropy difference term is zero, then the isentropic exponent is k. Delta $\Delta S'$ for the path can be zero when $Z = 1.0$. Conversely, a compressibility factor of unity is not a necessary and sufficient condition for an ideal isentropic path.

Equation 9.2 may be used to find, by successive approximations, the final temperature of an isentropic path for a given gas. (Final temperature must first be assumed to permit evaluating $C_P°$ and $\Delta S'$. For the present purposes of developing isentropic exponents, Equation 9.2 will be used in another way, avoiding this trial and error procedure.

Demonstration of Entropy Balance Method. Before discussing the development of a generalized isentropic exponent correlation by the entropy balance procedure, the application of Equation 9.1 will be demonstrated for

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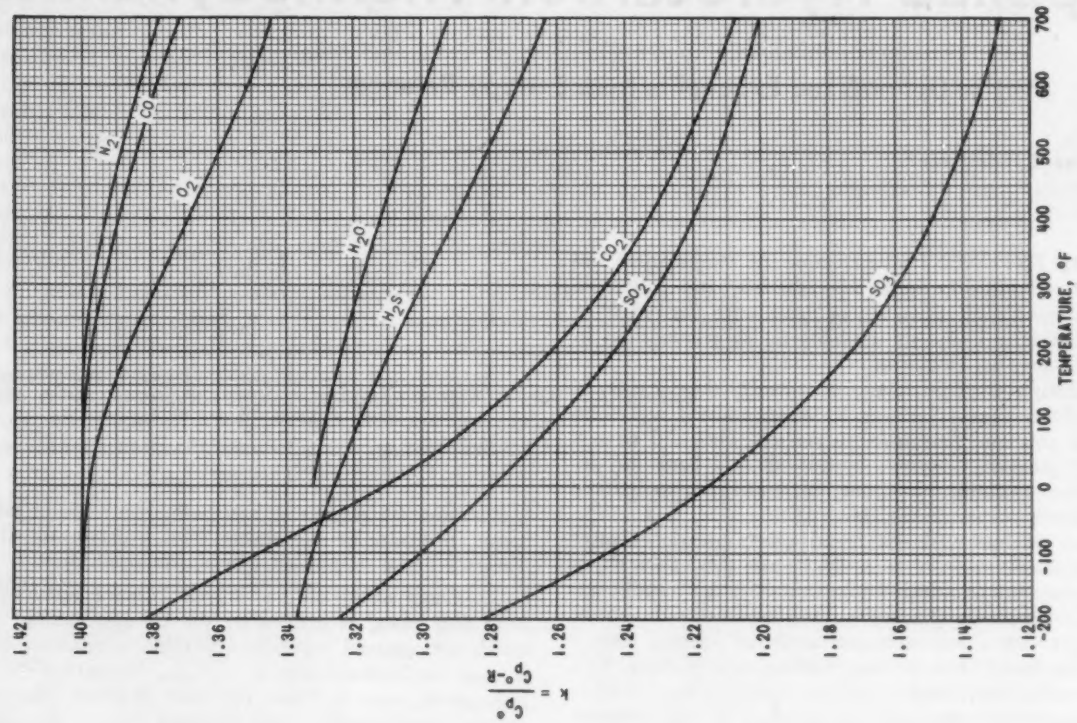


FIGURE 9.2—Isentropic exponent for gases in ideal gas state.

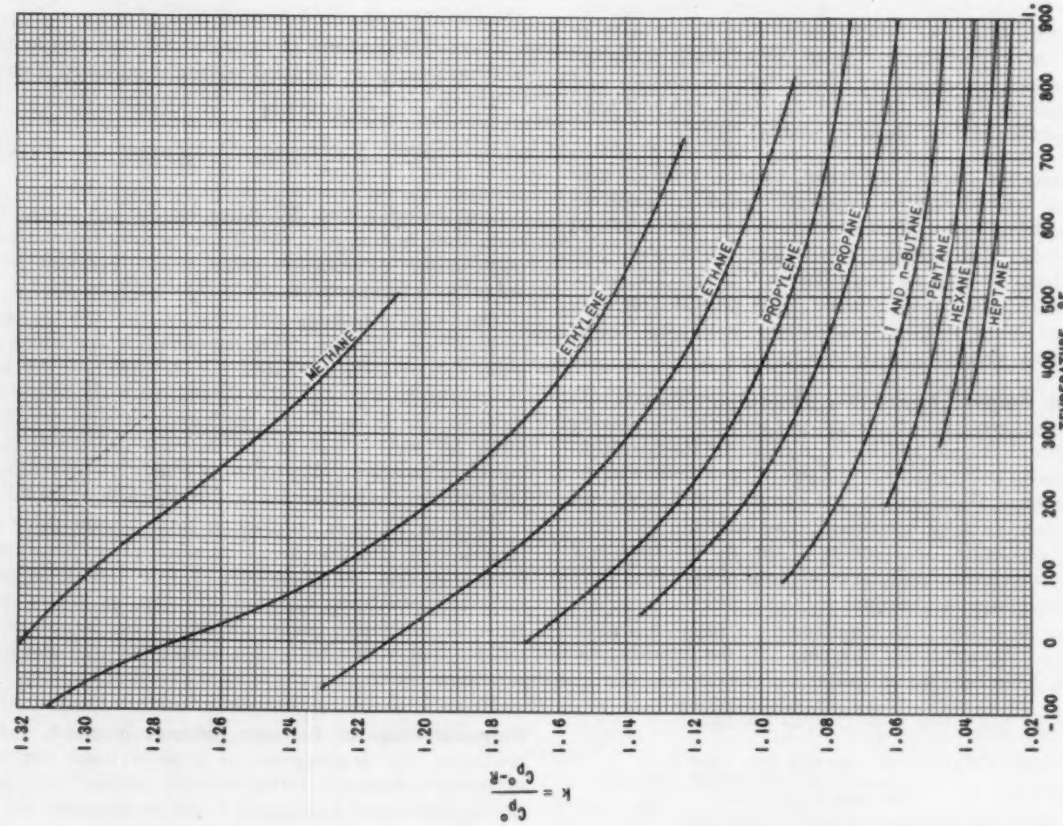


FIGURE 9.1—Isentropic exponent for hydrocarbons in ideal gas state.

the compression and expansion paths of the nine gases used in the polytropic development of Part 8.

These demonstration calculations are given in Tables 9.1 and 9.2 for the adiabatic Path D and the polytropic Paths C and E.

Values of ΔS were computed from terminal entropy values given in Table 8.2. Values of $\Delta S'$ were read from Figure 9.3. Table 7.5 is an alternate source of $\Delta S'$ values. Terminal temperatures and pressures were taken from Table 8.1.

The back-calculated $C_P°$ mean values given in Table 9.2 for Paths C, D, and E are essentially the same for each group and substance. Deviations from a constant value are largely due to the lack of precision in chart readings and calculations. As can be seen by the numerical values, the ΔS term accounts for the deviation of polytropic paths from the isentropic.

Isentropic Exponents from Entropy Balances. The entropy balance relationship of Equation 9.2 may be used to find the final temperature for isentropic compression, or expansion, of a given gas from given initial conditions to a final pressure. This calulation requires $\Delta S'$ and $C_P°$ mean

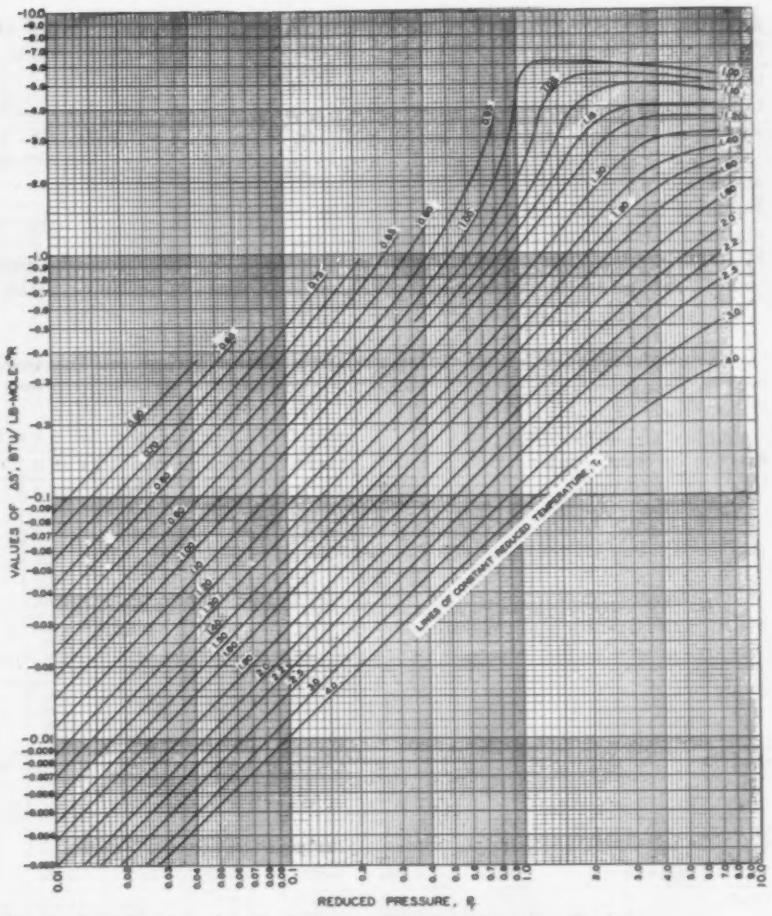


FIGURE 9.3—Generalized isothermal pressure correction to entropy of gases.

TABLE 9.1—Entropy Balance Calculations for Compression and Expansion Paths

Subst.	Operation	Group	GENERALIZED $\Delta S'$ Initial	GENERALIZED $\Delta S'$ Final Path C	GENERALIZED $\Delta S'$ Final Path D	GENERALIZED $\Delta S'$ Final Path E	ΔS (Table 8.2) Btu/lb. Mole, °F Path C	ΔS (Table 8.2) Btu/lb. Mole, °F Path E	$\Delta S - \Delta(\Delta S')$ Btu/lb. Mole, °F Path C	$\Delta S - \Delta(\Delta S')$ Btu/lb. Mole, °F Path D	$\Delta S - \Delta(\Delta S')$ Btu/lb. Mole, °F Path E
H_2O	Compression	I	—0.410	—0.670	—0.57	—0.53	—0.470	+0.366	—0.210	+0.160	+0.486
	Compression	II	—0.220	—0.540	—0.355	—0.266	—1.260	+1.040	—0.940	+0.135	+1.086
	Expansion	III	—0.57	—0.285	—0.410	—0.64	+0.928	—1.330	+0.643	—0.160	—1.26
	Expansion	IV	—0.355	—0.130	—0.220	—0.265	+1.47	—0.521	+1.245	—0.135	—0.611
NH_3	Compression	I	—0.054	—0.092	—0.078	—0.067	—0.830	+0.521	—0.792	+0.024	+0.534
	Compression	II	—0.167	—0.330	—0.255	—0.20	—0.806	+0.731	—0.643	+0.088	+0.764
	Expansion	III	—0.078	—0.0345	—0.054	—0.070	+0.998	—0.756	+0.9545	—0.024	—0.764
	Expansion	IV	—0.255	—0.112	—0.167	—0.195	+1.1925	—0.596	+1.0495	—0.088	—0.656
SO_2	Compression	I	—0.66	—1.25	—1.02	—0.75	—0.7045	+0.954	—0.1145	+0.3600	+1.044
	Compression	II	—0.155	—0.35	—0.265	—0.22	—1.044	+0.7045	—0.849	+0.1100	+0.7695
	Expansion	III	—1.02	—0.44	—0.66	—0.75	+1.114	—0.4035	+0.534	—0.3600	—0.705
	Expansion	IV	—0.265	—0.101	—0.155	—0.22	+1.095	—1.069	+0.931	—0.1100	—1.124
CH_4	Compression	I	—0.38	—0.64	—0.46	—0.345	—0.933	+0.810	—0.673	+0.0800	+0.775
	Compression	II	—0.128	—0.215	—0.175	—0.160	—0.659	+0.384	—0.572	+0.047	+0.416
	Expansion	III	—0.46	—0.22	—0.38	—0.60	+1.150	—1.021	+0.910	—0.0800	—0.881
	Expansion	IV	—0.175	—0.095	—0.128	—0.163	+0.814	—0.670	+0.734	—0.0470	—0.682
C_2H_4	Compression	I	—0.96	—1.40	—1.26	—1.10	—0.392	+0.700	+0.048	+0.3000	+0.840
	Compression	II	—0.23	—0.64	—0.51	—0.42	—1.035	+0.980	—0.615	+0.2800	+1.170
	Expansion	III	—1.26	—0.76	—0.96	—1.20	+0.252	—0.616	—0.248	—0.3000	—0.676
	Expansion	IV	—0.51	—0.17	—0.23	—0.27	+1.175	—0.420	+0.835	—0.2800	—0.661
C_2H_6	Compression	I	—0.50	—1.40	—1.15	—1.02	—0.687	+0.6015	+0.213	+0.6500	+1.1215
	Compression	II	—0.095	—0.37	—0.32	—0.295	—0.860	+0.6945	—0.585	+0.2250	+0.8945
	Expansion	III	—1.15	—0.31	—0.50	—0.70	+1.376	—1.278	+0.536	—0.6500	—1.728
	Expansion	IV	—0.32	—0.10	—0.095	—0.15	+0.887	—1.140	+0.667	—0.2250	—1.310
CH_3Cl	Compression	I	—0.33	—0.50	—0.41	—0.35	—0.49	+0.778	—0.32	+0.0800	+0.798
	Compression	II	—0.13	—0.37	—0.27	—0.190	—1.293	+1.535	—1.053	+0.1400	+1.595
	Expansion	III	—0.41	—0.285	—0.33	—0.42	+0.535	—0.611	+0.410	—0.0800	—0.601
	Expansion	IV	—0.27	—0.089	—0.13	—0.20	+1.283	—1.358	+1.102	—0.1400	—1.428
CCl_2F_2	Compression	I	—0.220	—0.780	—0.600	—0.520	—0.968	+0.940	—0.408	+0.3800	+1.240
	Compression	II	—0.144	—0.43	—0.390	—0.330	—0.866	+0.852	—0.580	+0.2460	+1.038
	Expansion	III	—0.60	—0.195	—0.220	—0.270	+0.966	—0.995	+0.561	—0.3800	—1.325
	Expansion	IV	—0.39	—0.119	—0.144	—0.165	+1.135	—0.924	+0.864	—0.2460	—1.149
$CHClF_2$	Compression	I	—0.330	—0.76	—0.59	—0.49	—0.813	+0.908	—0.383	+0.2600	+1.068
	Compression	II	—0.112	—0.37	—0.30	—0.265	—0.995	+0.718	—0.737	+0.1880	+0.871
	Expansion	III	—0.59	—0.25	—0.33	—0.40	+0.986	—0.787	+0.646	—0.2600	—0.977
	Expansion	IV	—0.30	—0.09	—0.112	—0.155	+1.098	—1.141	+0.858	—0.1880	—1.286

values, which are dependent upon the terminal conditions. Thus, successive approximations are necessary in solving Equation 9.2 for the final temperature.

With $\Delta S'$ given as a generalized function of reduced temperature and pressure, i.e., Figure 9.3 and Table 7.5, Equation 9.2 can be used to find a gas that will satisfy assumed terminal conditions, i.e., initial and final T_r and P_r values.

At these assumed terminal T_r and P_r conditions, values of $\Delta S'$ are found, and the residual entropy difference is found.

$$\Delta(\Delta S') = \Delta S'_2 - \Delta S'_1 \qquad (9.3)$$

Then, $C_P°_{mean}$ is found from Equation 9.2, substituting the identities: $T_{r2}/T_{r1} \equiv T_2/T_1$ and $P_{r2}/P_{r1} \equiv P_2/P_1$. Next, the average ideal gas state exponent for the path is found by

$$k_{path} = \frac{C_P°_{mean}}{C_P°_{mean} - R} \qquad (9.4)$$

From the terminal T_r and P_r values of the assumed isentropic paths, the values of the isentropic exponents,

TABLE 9.2
Back Calculated Mean Heat Capacities for Compression and Expansion Paths via Entropy Relationship

Subst.	Operation	Group	R ln P_2/P_1	ln T_2/T_1			$\Delta S - \Delta(\Delta S') + R \ln P_2/P_1$			$C°_{P_{mean}} = \frac{\Delta S - \Delta(\Delta S') + R \ln P_2/P_1}{\ln T_2/T_1}$		
				Path C	Path D	Path E	Path C	Path D	Path E	Path C	Path D	Path E
H_2O	Compression	I	+2.755	0.2777	0.317	0.3487	2.545	2.915	3.241	9.17	9.20	9.30
	Compression	II	+4.29	0.3819	0.497	0.5955	3.35	4.425	5.376	8.78	8.90	9.03
	Expansion	III	−2.755	−0.2342	−0.317	−0.4192	−2.112	−2.915	−4.015	9.01	9.20	9.35
	Expansion	IV	−4.29	−0.3468	−0.497	−0.546	−3.045	−4.425	−4.901	8.79	8.90	8.975
NH_3	Compression	I	+2.53	0.1932	0.2799	0.3321	1.738	2.554	3.064	9.00	9.13	9.22
	Compression	II	+3.56	0.3308	0.4055	0.4742	2.917	3.648	4.324	8.82	9.00	9.12
	Expansion	III	−2.53	−0.1708	−0.2799	−0.365	−1.5755	−2.554	−3.294	9.22	9.13	9.03
	Expansion	IV	−3.56	−0.277	−0.4055	−0.454	−2.5105	−3.648	−4.216	9.06	9.00	9.28
SO_2	Compression	I	+3.20	0.2957	0.341	0.4055	3.0855	3.56	4.244	10.44	10.44	10.47
	Compression	II	+3.20	0.2288	0.317	0.3750	2.351	3.31	3.9695	10.29	10.57	10.58
	Expansion	III	−3.20	−0.2515	−0.341	−0.3725	−2.666	−3.56	−3.905	10.60	10.44	10 48
	Expansion	IV	−3.20	−0.2158	−0.317	−0.4125	−2.269	−3.31	−4.344	10.52	10.57	10.53
CH_4	Compression	I	+3.20	0.322	0.4175	0.5040	+2.527	+3.28	+3.975	7.85	7.86	7.89
	Compression	II	+2.26	0.207	0.2820	0.3257	+1.688	+2.307	+2.676	8.16	8.18	8.22
	Expansion	III	−3.20	−0.2878	−0.4175	−0.527	−2.290	−3.28	−4.081	7.96	7.86	7.75
	Expansion	IV	−2.26	−0.1840	−0.2820	−0.3624	−1.526	−2.307	−2.942	8.29	8.18	8.10
C_2H_4	Compression	I	+2.182	0.2222	0.2455	0.2868	+2.230	+2.348	+3.022	10.05	9.56	10.54
	Compression	II	+3.20	0.1873	0.257	0.3208	+2.585	+3.48	+4.370	13.81	13.53	13.61
	Expansion	III	−2.182	−0.2058	−0.2455	−0.289	−2.430	−2.348	−2.858	11.82	9.56	9.89
	Expansion	IV	−3.20	−0.1911	−0.257	−0.3285	−2.365	−3.48	−3.861	12.38	13.54	11.76
C_3H_6	Compression	I	+4.13	0.330	0.375	0.4055	4.343	4.78	5.252	13.15	12.75	12.95
	Compression	II	+3.20	0.162	0.2078	0.246	2.615	3.425	4.0945	16.15	16.50	16.65
	Expansion	III	−4.13	−0.2704	−0.375	−0.465	−3.594	−4.78	−5.858	13.29	12.75	12.60
	Expansion	IV	−3.20	−0.1503	−0.2078	−0.2838	−2.533	−3.425	−4.51	16.85	16.50	15.90
CH_3Cl	Compression	I	+1.898	0.1458	0.1824	0.2370	+1.578	+1.978	+2.696	10.83	10.85	11.37
	Compression	II	+4.053	0.2850	0.3820	0.4950	+3.000	+4.193	+5.648	10.53	10.98	11.42
	Expansion	III	−1.898	−0.1370	−0.1824	−0.2325	−1.488	−1.978	−2.499	10.86	10.85	10.75
	Expansion	IV	−4.053	−0.260	−0.3820	−0.516	−2.951	−4.193	−5.481	11.35	10.98	10.62
CCl_2F_2	Compression	I	+3.41	0.1647	0.2088	0.2515	+3.002	+3.79	+4.65	18.22	18.15	18.49
	Compression	II	+2.942	0.1214	0.159	0.19475	+2.362	+3.188	+3.980	19.46	20.05	20.43
	Expansion	III	−3.41	−0.1566	−0.2088	−0.2665	−2.849	−3.79	−4.735	18.19	18.15	17.78
	Expansion	IV	−2.942	−0.1037	−0.159	−0.2045	−2.078	−3.188	−4.091	20.05	20.05	20.00
$CHClF_2$	Compression	I	+2.927	0.1919	0.241	0.297	+2.544	+3.187	+3.995	13.26	13.23	13.45
	Compression	II	+3.275	0.1672	0.224	0.2647	+2.538	+3.463	+4.146	15.17	15.45	15.67
	Expansion	III	−2.927	−0.1672	−0.241	−0.301	−2.281	−3.187	−3.904	13.64	13.22	12.96
	Expansion	IV	−3.275	−0.1439	−0.224	−0.2958	−2.387	−3.463	−4.561	16.59	15.45	15.43

TABLE 9.3 Sample of Generalized Back Calculations to find $C_P°$ and Isentropic Exponents

Generalized Properties	Initial	P_2/P_1	FINAL CONDITIONS FOR PATH							
			2:1	3:1	2:1	3:1	4:1	2:1	3:1	4:1
T_r	0.8		0.85	0.85	0.90	0.90	0.90	0.95	0.95	0.95
P_r	0.1		0.2	0.3	0.2	0.30	0.40	0.20	0.30	0.40
RZ	1.82		1.70	1.530	1.75	1.62	1.465	1.79	1.690	1.58
$\Delta S'$	−0.395		− 0.67	− 1.14	− 0.518	− 0.850	− 1.260	− 0.400	− 0.640	− 0.94
Mean $C_P°$ for Path										
T_2/T_1			1.0625	1.0625	1.125	1.125	1.125	1.1875	1.1875	1.1875
ln T_2/T_1			0.0606	0.0606	0.1179	0.1179	0.1179	0.1719	0.1719	0.1719
ln P_2/P_1			0.693	1.098	0.693	1.098	1.386	0.693	1.098	1.386
R ln P_2/P_1			1.378	2.184	1.378	2.184	2.757	1.378	2.184	2.757
$\Delta(\Delta S') = \Delta S'_2 - \Delta S'_1$			− 0.275	− 0.745	− 0.123	− 0.455	− 0.865	− 0.005	− 0.245	− 0.545
R ln $P_2/P_1 - \Delta(\Delta S')$			1.653	2.929	1.501	2.639	3.502	1.383	2.429	3.302
$C_P°_{mean}$			27.28	48.30	12.74	22.38	29.70	8.04	14.13	19.20
Exponent for Path										
$k = C_P°/(C_P° - R)$			1.080	1.0435	1.1855	1.0985	1.072	1.331	1.165	1.116
$(k-1)/k$			0.0741	0.0417	0.1565	0.0897	0.0672	0.2486	0.1416	0.104
$Cp°$ ln P_2/P_1			18.9	53.0	8.83	24.59	41.17	5.575	15.52	26.48
$M = \Delta(\Delta S')/C_P°$ ln (P_2/P_1)			− 0.01455	− 0.01406	− 0.01394	− 0.0185	− 0.02102	− 0.0009	− 0.01578	− 0.0206
Z_1/Z_2			1.07	1.19	1.04	1.123	1.243	1.017	1.0775	1.1525
ln (Z_1/Z_2)			0.0676	0.174	0.0392	0.116	0.2175	0.01685	0.0746	0.142
$N = \ln(Z_1/Z_2)/\ln(P_2/P_1)$			0.0976	0.1585	0.0566	0.1056	0.1569	0.243	0.068	0.1025
$M + N$			0.08305	0.14444	0.04266	0.0871	0.13788	0.0234	0.05222	0.0819
$[(n'-1)/n'] = [(k-1)/k] - M$			0.08865	0.05526	0.17044	0.1082	0.08822	0.2495	0.15738	0.1246
n'			1.0975	1.059	1.2055	1.122	1.096	1.333	1.186	1.143
$(n'-k)$			0.0175	0.0155	0.02	0.0235	0.024	0.002	0.021	0.027
$(n-1)/n = (k-1)/k - (M + N)$			− 0.00895	− 0.10274	0.11384	0.0026	− 0.07068	0.2252	0.08938	0.02375
n			0.991	0.907	1.128	1.0035	0.934	1.291	1.098	1.024
$(n-k)$			− 0.089	− 0.1465	− 0.0775	− 0.0950	− 0.148	− 0.04	− 0.067	− 0.092

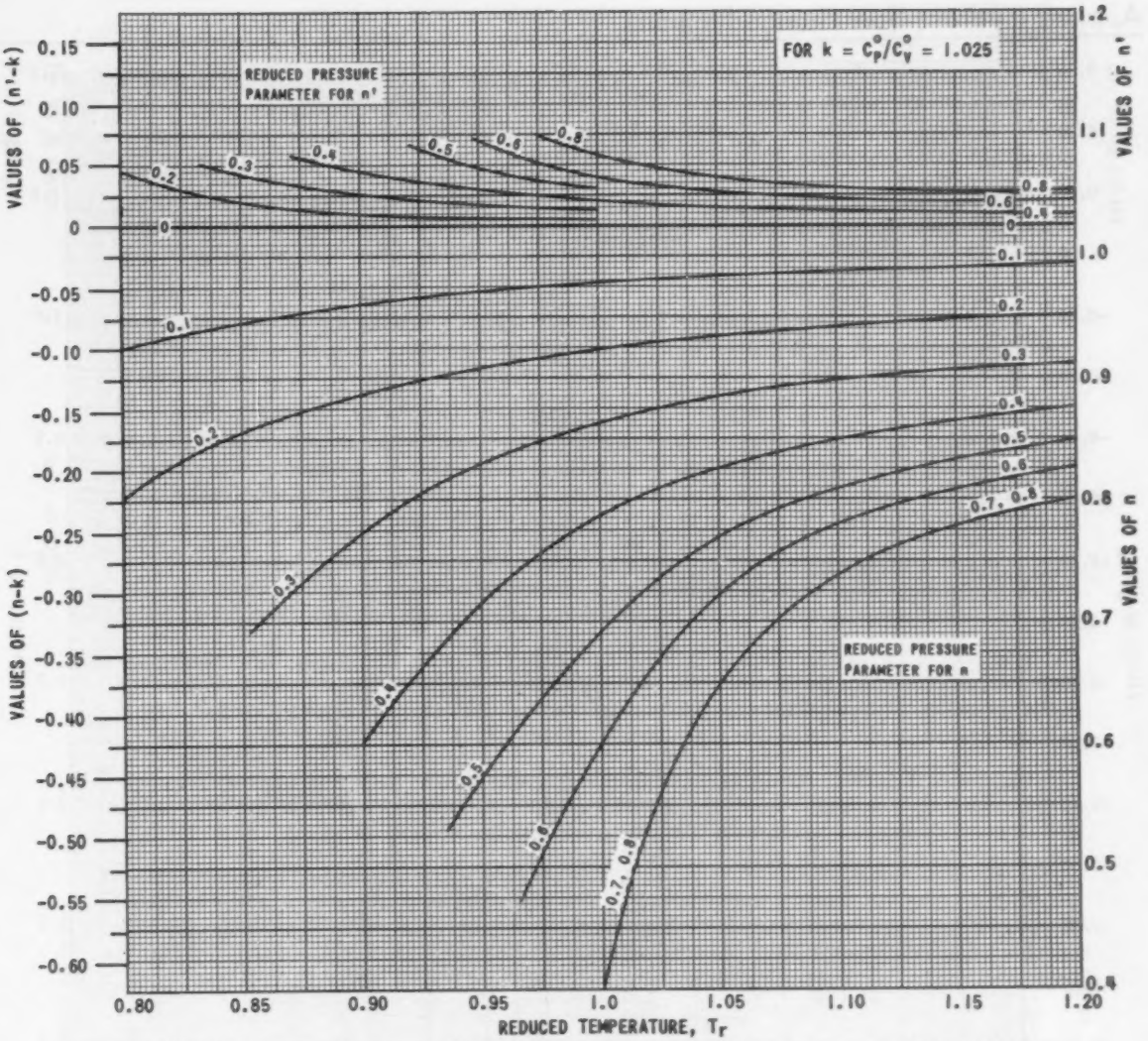


FIGURE 9.4—Isentropic exponent differences from reduced temperature and pressure for k = 1.025.

n′ that defines temperature changes, and n that defines volume changes with pressure, can be found by Equations 7.5 and 7.6. Thus, the values of k, n′, and n are found for the same paths. These are the data that have been derived and used in developing the generalized isentropic exponent correlations presented in this installment.

The equations relating these exponents follow: Rearranging Equation 9.2 and replacing R/C_P° by its equivalent $(k-1)/k$ gives

$$\ln \frac{T_2}{T_1} = \left[\frac{k-1}{k} - \frac{\Delta(\Delta S')}{C_P^\circ \ln \frac{P_2}{P_1}}\right] \ln \frac{P_2}{P_1} \qquad (9.5)$$

Comparing Equation 9.5 with the definition of the isentropic temperature change exponent as expressed by Equation 7.5 gives the following relation between n′ and k

$$\left[\frac{k-1}{k} - \frac{n'-1}{n'}\right] = \left[\frac{\Delta(\Delta S')}{C_P^\circ \ln \frac{P_2}{P_1}}\right] = M \qquad (9.6)$$

Equations 9.5 and 9.6 may be used together to find values of n′, the isentropic temperature change exponent.

An equation relating the volume change exponent with the temperature change exponent is obtained from the definitions of n and n′ and of the compressibility factor, as follows:

Combining Equation 7.6 ($P_1V^n{}_1 = P_2V^n{}_2$) and the compressibility factor relationship ($PV = ZRT$), eliminating V and rearranging gives

$$\frac{T_2}{T_1} = \frac{Z_1}{Z_2}\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} \qquad (9.7)$$

Equating the ratio T_2/T_1 from Equation 7.5 to that from Equation 9.7 gives

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n'-1}{n'}} = \frac{Z_1}{Z_2}\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} \qquad (9.8)$$

$$\left[\left(\frac{n'-1}{n'}\right) - \left(\frac{n-1}{n}\right)\right] = \left(\frac{\ln \frac{Z_1}{Z_2}}{\ln \frac{P_2}{P_1}}\right) = N \qquad (9.9)$$

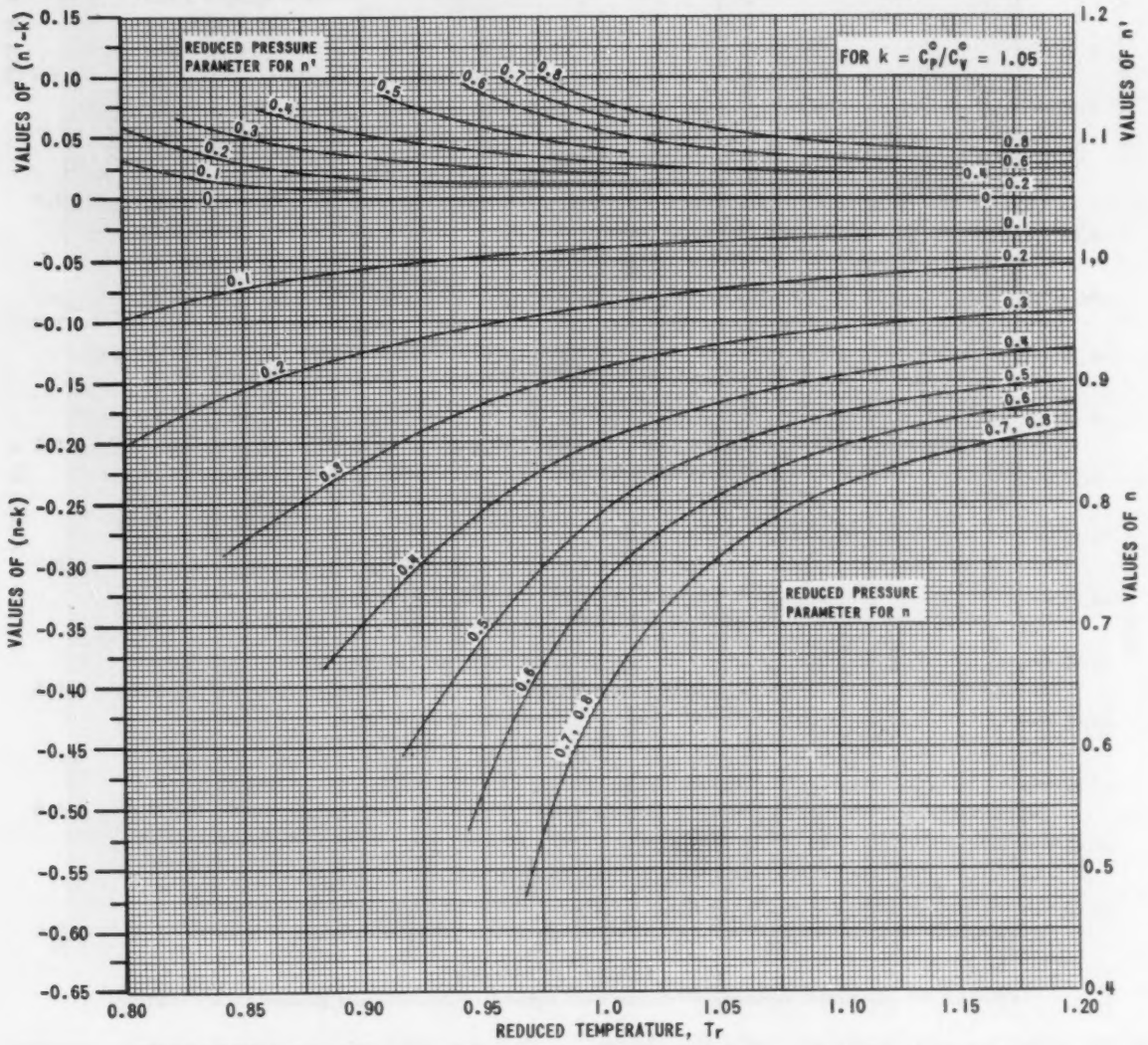


FIGURE 9.5—Isentropic exponent differences from reduced temperature and pressure for k = 1.05.

$$\left[\left(\frac{k-1}{k}\right)-\left(\frac{n-1}{n}\right)\right]=\left[\frac{\ln\frac{Z_1}{Z_2}+\frac{\Delta(\Delta S')}{C_P^\circ}}{\ln\frac{P_2}{P_1}}\right]=(N+M) \qquad (9.10)$$

Equations 9.6 and 9.10 are analogous relationships for the two real gas exponents. The right hand sides of these equations are generalized functions of reduced temperature and pressure and of C_P° (or k).

Calculation of Isentropic Exponents. Equations 9.2, 9.6, and 9.10 are for isentropic paths of finite length, starting at (P_1, T_1) and ending at (P_2, T_2). Mean values of C_P°, k, n′, and n for the path are required to make the equations valid. The residual entropy, $\Delta S'$, and the compressibility factor, Z, terms are required at the terminals of the path for validity. As the terminal compressibility factors appear in Equation 9.10 as a ratio, values of RZ can be used just as well because of the identity $(Z_1/Z_2) \equiv (RZ_1/RZ_2)$.

Using the above equations and the tables of generalized thermodynamic properties, the calculations illustrated in Table 9.3 were made for over 200 paths. The procedure was as follows:

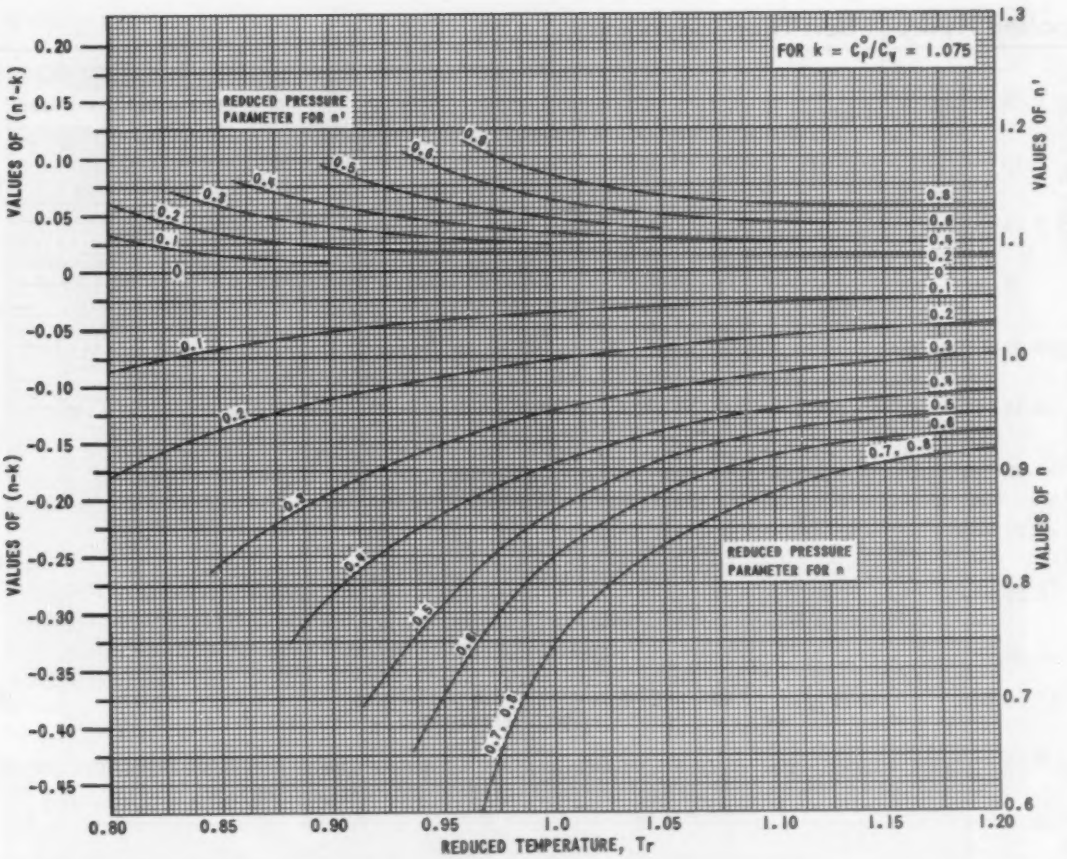
1. Initial and final conditions (reduced temperature and pressure) were assumed at even values for each path to permit direct readings from Table 7.5.

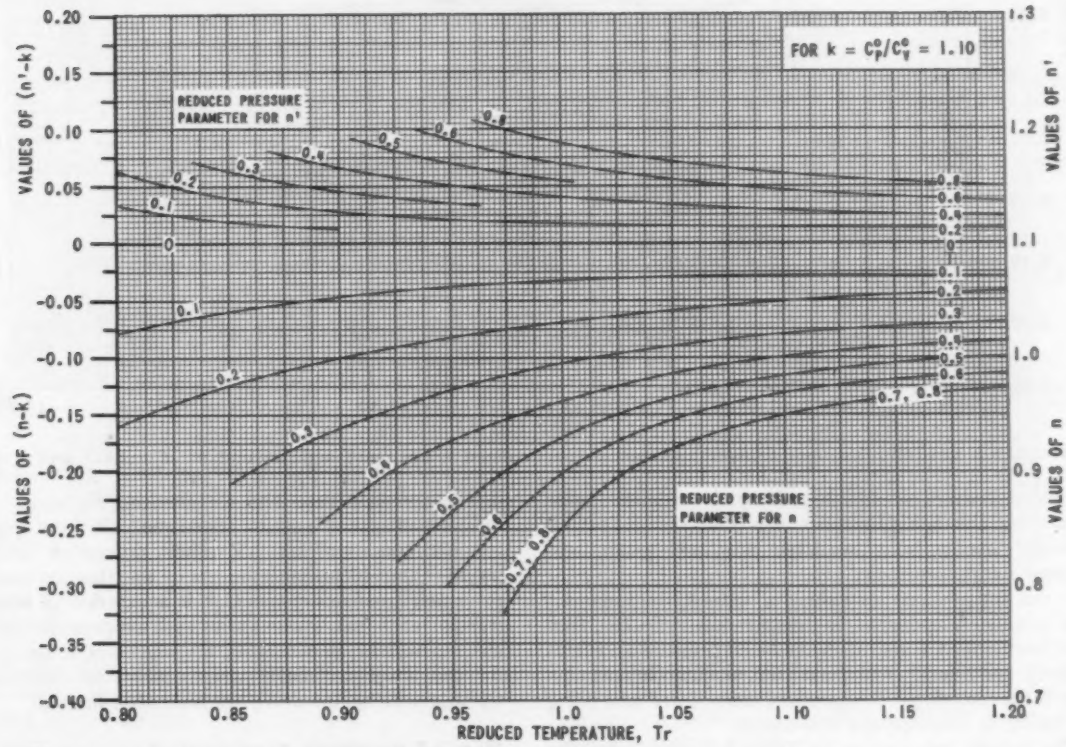
For most of the paths, the compression ratio was 2:1. Higher compression ratios paths were included for some of the same starting conditions.

2. Readings of RZ and $-\Delta S'$ were made for these initial and final conditions from the generalized values in Table 7.5.

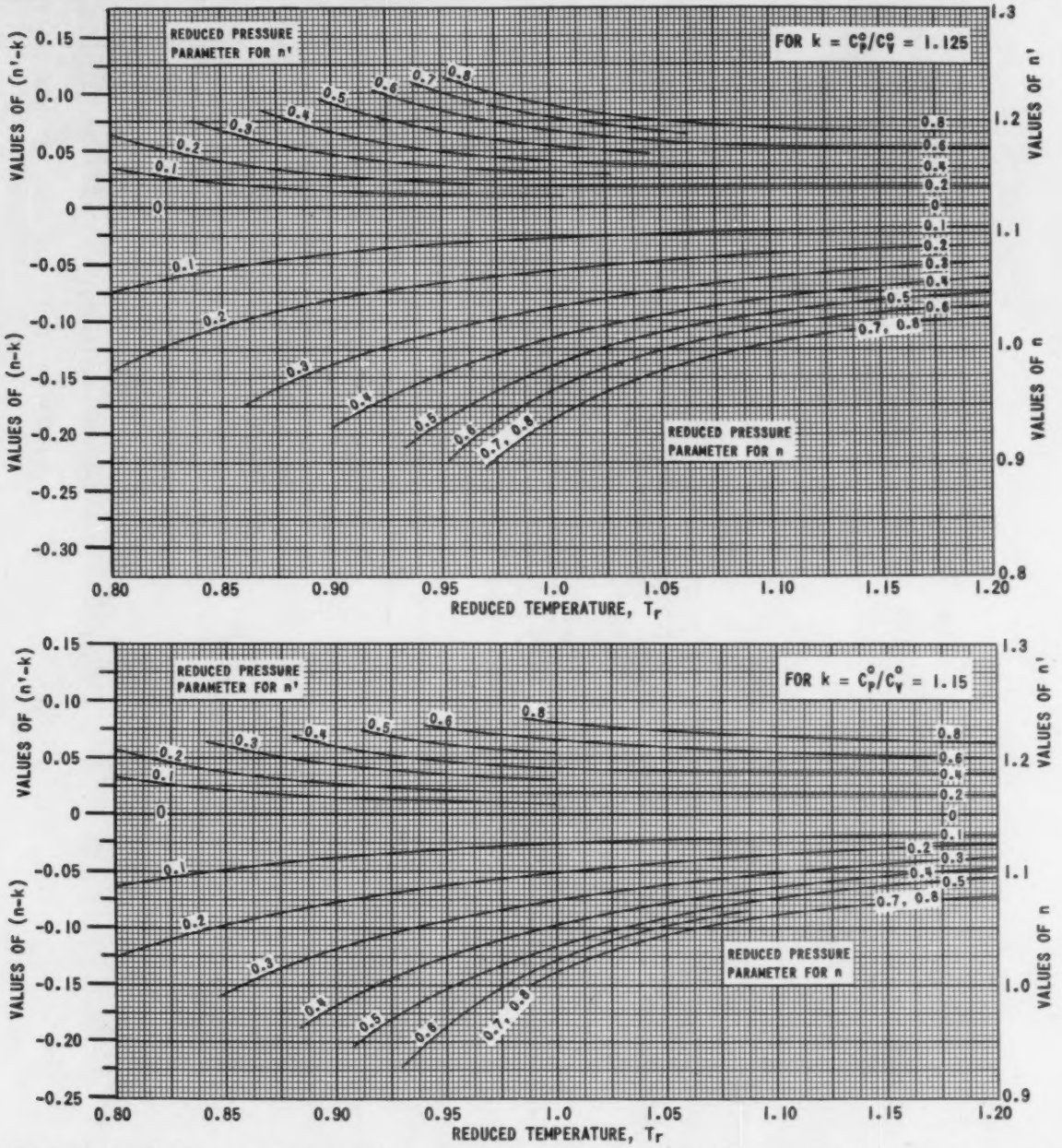
3. Mean C_P° values were computed as illustrated in Table 9.3.

4. Values of the exponent differences (n′—k) and (n—k) were next computed.





FIGURES 9.6 and 9.7—Isentropic exponent differences from reduced temperature and pressure for k = 1.075 and k = 1.10.



FIGURES 9.8 and 9.9—Isentropic exponent differences from reduced temperature and pressure for k = 1.125 and k = 1.15.

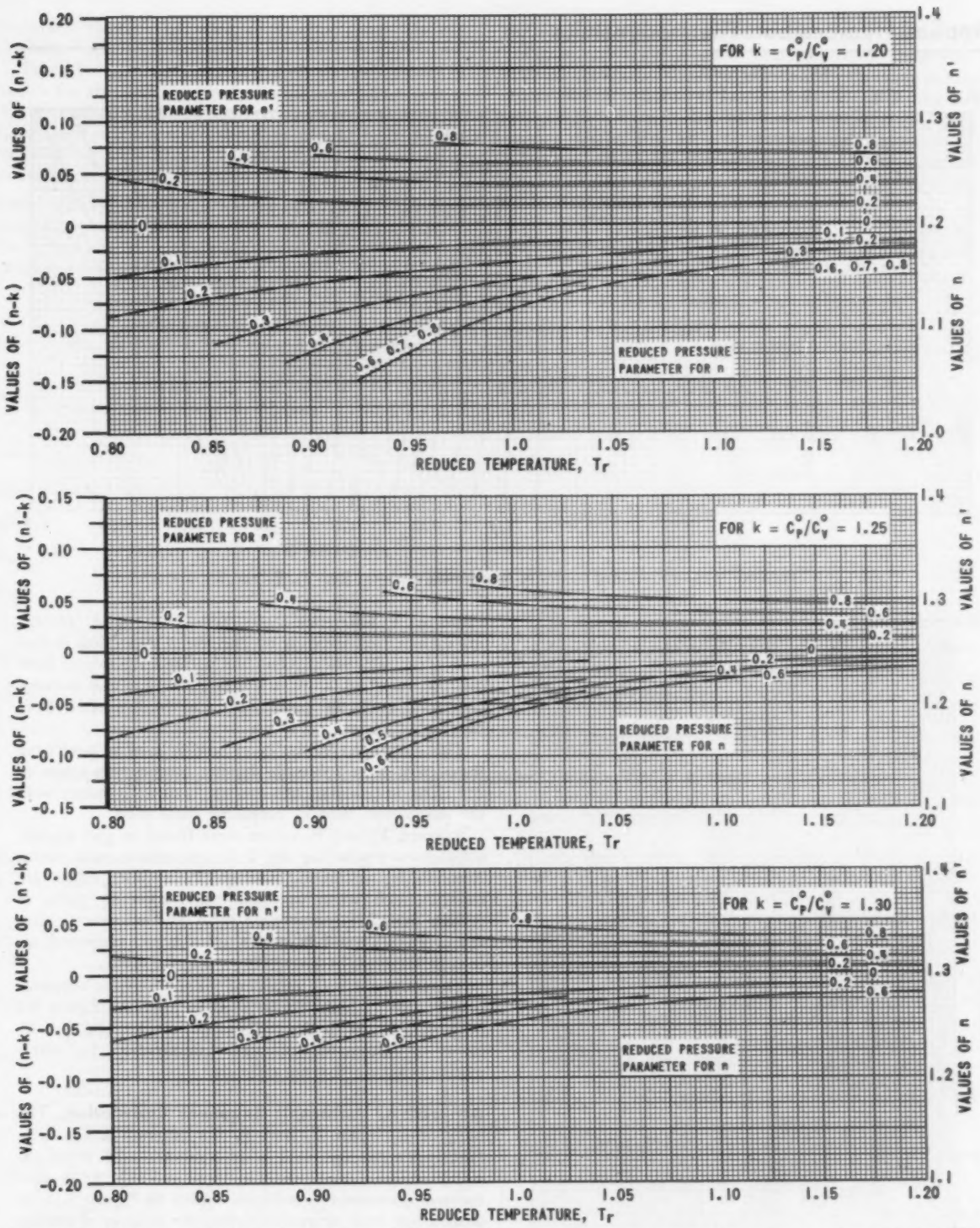
This procedure of assuming the path and then back calculating the gas properties was followed to permit working directly from available tabulated generalized thermodynamic properties.

It was found that the values of (n'—k) and (n—k) were largely independent of compression ratio but they were functions of k and of the reduced pressure and temperature conditions. This permitted making the calculations for a convenient compression ratio of 2:1 and using the results in developing a correlation.

The sample calculations in Table 9.3 are all for the same initial conditions but different final conditions, varying compression ratio and the resulting $C_P°_{mean}$.

Calculating $C_P°_{mean}$ by Equation 9.2 from reduced terminal conditions and $\Delta S'$ values, defines an isentropic path without identifying the gas or the absolute temperatures and pressures. Since $C_P°$ is a function of temperature for each gas, k also varies with temperature for each gas. As will be shown later, the values of k are greater for the lower molecular weight gases, so variations of $C_P°_{mean}$ with temperature are somewhat limited.

Plots of Isentropic Exponents. From the calculations described above and illustrated in Table 9.3, plots of n



FIGURES 9.10, 9.11, and 9.12—Isentropic exponent differences from reduced temperature and pressure for k = 1.20, k = 1.25 and k = 1.30.

and n′ were prepared. These plots are given as Figures 9.4 through 9.12, each for a different value of k (from 1.025 to 1.30) for the path.

In each of these nine plots, the exponents n and n′ are plotted against T_r for lines of constant P_r. There are two P_r parameters, one for n and one for n′, on each chart. It will be noted that values of n are always less than the corresponding k value, while the values of n′ are always greater than k.

For more convenient interpolation, at intermediate

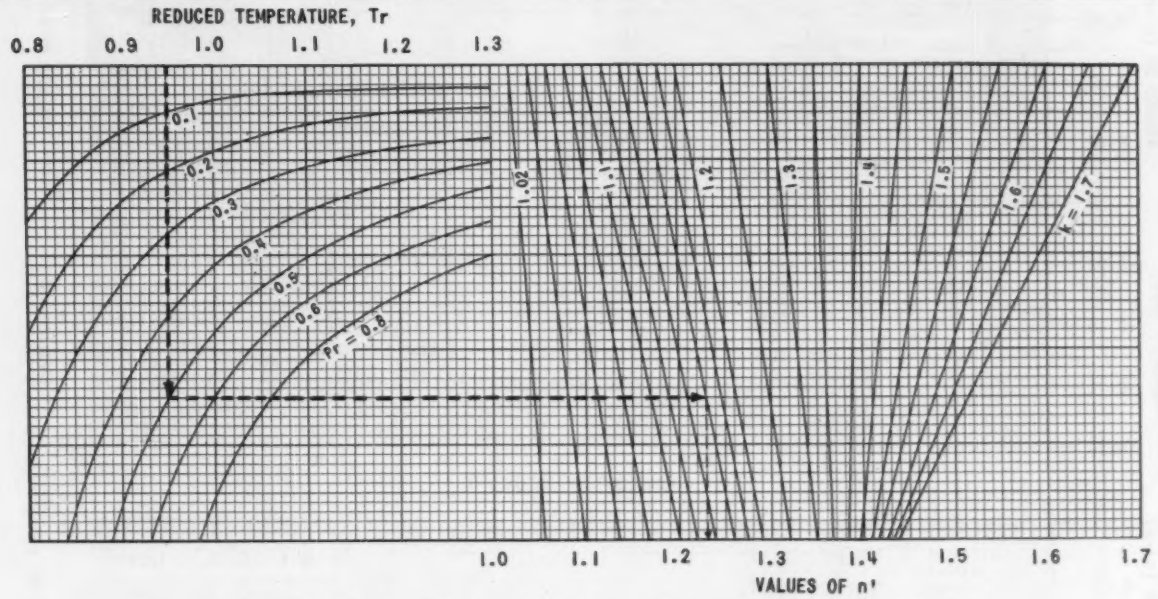


FIGURE 9.13—Generalized isentropic temperature exponent from T_r, P_r, and K.

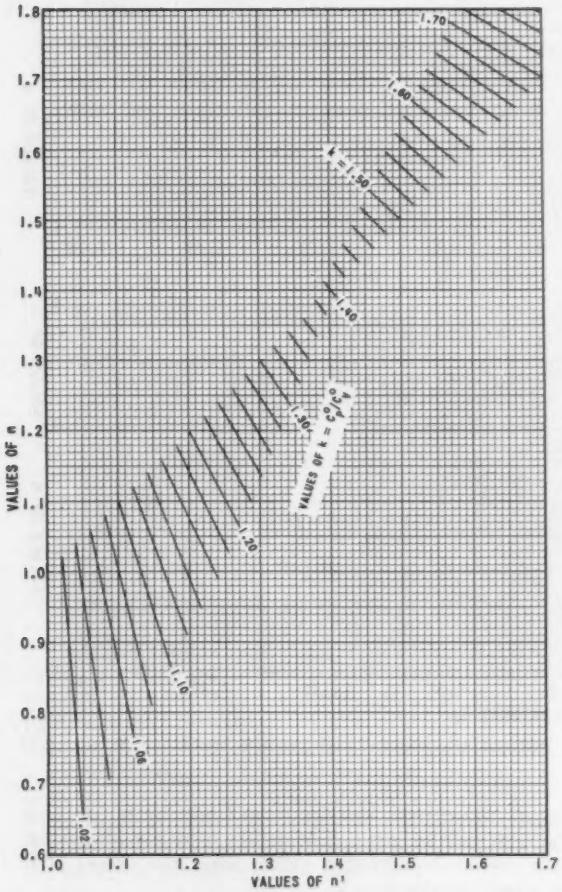


FIGURE 9.14—Volume change exponent from temperature and ideal gas exponents for isentropic paths.

values of k, difference scales, i.e., (n—k) and (n′—k), are included on these plots. The use of these plots to find n or n′ for any gas involves the preliminary step of finding the value of k for the particular gas and average temperature of the path. This can be estimated from Figures 9.1 and 9.2.

The calculated values of n′ and n used in preparing these plots were for paths having compression ratios of 2:1. The initial (i.e., the lower) P_r and T_r values were the parameters used in preparing these plots.

Average T_r and P_r values were found to give equally satisfactory results for the 2:1 compression ratio paths. Accordingly, arithmetic average T_r and P_r values are recommended when applying these plots to paths of greater than 2:1 compression ratio. For expansion paths, the average T_r and P_r values are also recommended, although the final or lower values may be used.

The ideal gas state exponent for the average temperature of the path should be used in applying Figure 9.4 through 9.12. With the differences (n′—k) and (n—k) given, as alternate ordinates, interpolation for intermediate values of k is not difficult.

Generalized Isentropic Exponent Correlation. The plots of n′ versus T_r and P_r for different k values in Figures 9.4 through 9.12 were combined with more entropy balance calculations, like those in Table 9.3, to give the two parameter correlation shown in Figure 9.13. A dashed line with arrows illustrates the method of finding n′ values from this correlation.

Figure 9.14 is a companion chart for finding the isentropic volume change exponent n from n′ and k. Below $k = 1.38$ n′ values will be greater than k, while n will be less than k. Above $k = 1.38$ the opposite is true, i.e., $n' < k$ and $n > k$.

Generally, only two types of gases have isentropic exponents above 1.38. Diatomic gases (H_2, N_2, and O_2)

have a k value of 1.4, while monatomic gases (He and A) have a k value of 1.67.

These two correlations were used to find n′ and n values for the isentropic paths of the nine gases used in the previous calculations and are presented in Table 9.4. Calculated or correlation values of n′ and n are shown to be in excellent agreement with the "observed" values from Table 8.3.

Polytropic Exponents. In the pervious installment, Part 8, two charts, Figures 8.5 and 8.6, were presented for estimating the polytropic temperature change exponents from the corresponding adiabatic exponent, n'_a, the adiabatic efficiency, e_a, and the ideal gas exponent, k.

Figures 8.5 and 8.6 can be applied with the new generalized correlation for n′ to obtain the polytropic value, i.e., n'_p. This calculation is demonstrated in Tables 9.5 and 9.6 for polytropic Paths C and E for the nine substances studied previously. As can be seen, the values of n'_p calculated by the use of Figures 9.13, 8.5, and 8.6 are in excellent agreement with the "observed" values of n'_p from Table 8.3.

Polytropic corrections to the volume change exponent, n, obtained from Figure 9.14 require another correlation.

Two charts, Figures 9.15 and 9.16, were prepared from

TABLE 9.4 Demonstration of Exponent Prediction Methods for Isentropic Paths

			IDEAL GAS			REDUCED COND.		n′			n		
Subs't.	Operation	Group	T_{avg} °F	$C^{\circ}_{P_{mean}}$	k	$(T_r)_{avg}$	$(P_r)_{avg}$	Calc.[1]	Obs.[3]	% Error	Calc.[2]	Obs.[3]	% Error
H_2O	Comp.	I	763	8.90	1.2875	1.050	0.390	1.30	1.295	+0.386	1.27	1.278	−0.625
	Comp.	II	677	8.77	1.2930	0.979	0.226	1.30	1.298	+0.154	1.29	1.288	+0.155
NH_3	Comp.	I	248	9.21	1.2752	0.970	0.042	1.28	1.282	−0.156	1.27	1.278	−0.625
	Comp.	II	177	8.91	1.2871	0.874	0.093	1.30	1.293	+0.541	1.27	1.274	−0.313
SO_2	Comp.	I	310	9.74	1.2564	0.994	0.527	1.29	1.268	+1.735	1.18	1.183	−0.253
	Comp.	II	323	9.75	1.2560	1.016	0.1578	1.26	1.245	+1.204	1.24	1.227	+1.059
CH_4	Comp.	I	−95	7.76	1.3443	1.062	0.357	1.35	1.35	0	1.33	1.32	+0.757
	Comp.	II	−7	8.19	1.3204	1.318	0.245	1.32	1.33	−0.751	1.32	1.315	+0.380
C_2H_4	Comp.	I	87	10.53	1.2327	1.072	0.785	1.28	1.287	−0.543	1.15	1.19	−3.361
	Comp.	II	195	12.15	1.1956	1.29	0.588	1.22	1.189	+2.607	1.14	1.185	−3.797
C_2H_6	Comp.	I	105	13.05	1.1797	1.027	0.635	1.24	1.221	+1.556	1.10	1.122	−1.960
	Comp.	II	299	16.26	1.1393	1.380	0.423	1.16	1.148	+1.045	1.09	1.122	−2.852
CH_3Cl	Comp.	I	234	11.23	1.2150	0.928	0.186	1.235	1.2355	−0.040	1.18	1.1855	−0.463
	Comp.	II	216	11.05	1.2193	0.904	0.117	1.23	1.227	+0.244	1.20	1.2235	−1.920
CCl_2F_2	Comp.	I	165	19.06	1.1163	0.902	0.203	1.14	1.1385	+0.131	1.04	1.08	−3.703
	Comp.	II	290	21.01	1.1045	1.084	0.232	1.12	1.12	0	1.06	1.09	−2.752
$CHClF_2$	Comp.	I	131	13.72	1.1694	0.888	0.206	1.20	1.1955	+0.376	1.11	1.122	−1.069
	Comp.	II	283	15.87	1.1463	1.117	0.216	1.16	1.156	+0.346	1.11	1.112	−0.179
										avg 0.66			avg 1.5

[1] Figure 9.13 [2] Figure 9.14 [3] Table 8.3

TABLE 9.5 Demonstration of Exponent Prediction Methods for Polytropic Paths C (where $e_a < 1.0$)

			Ideal Gas			Reduced Condition		Ad. Eff. e_a Table 8.6	TEMPERATURE EXPONENTS n′					VOLUME EXPONENT n			
Subs't	Operation	Group	T_{avg} °F	$C^{\circ}_{P_{mean}}$	k	T_r avg	P_r avg		Calc. n'_a Fig. 9.13	Poly Corr. Fig. 8.5	Calc. n'_p Fig. 8.6	Obs. n'_p Table 8.3	% Error	Calc. n_a Fig. 9.14	Calc. n_p Fig. 9.15	Obs. n_p Table 8.3	% Error
H_2O	Compression	I	735	8.85	1.2896	1.027	0.390	0.806	1.305	0.88	1.255	1.251	+0.319	1.265	1.215	1.210	+0.413
	Compression	II	600	8.65	1.2983	0.912	0.226	0.710	1.310	0.81	1.24	1.215	+2.057	1.255	1.19	1.175	+1.277
	Expansion	III	608	9.00	1.2834	1.090	0.390	0.635	1.300	0.75	1.21	1.240	−2.419	1.26	1.27	1.155	+9.957
	Expansion	IV	748	8.88	1.2884	1.039	0.226	0.637	1.310	0.72	1.205	1.191	+1.175	1.26	1.15	1.166	−1.372
NH_3	Compression	I	215	9.08	1.2802	0.937	0.042	0.670	1.290	0.69	1.18	1.179	+0.084	1.265	1.15	1.167	−1.457
	Compression	II	150	8.79	1.2922	0.836	0.093	0.769	1.30	0.805	1.23	1.226	+0.326	1.280	1.21	1.188	+1.852
	Expansion	III	284	9.36	1.2696	1.018	0.042	0.598	1.27	0.62	1.153	1.155	−0.173	1.27	1.15	1.143	+0.612
	Expansion	IV	213	9.06	1.2810	0.922	0.093	0.637	1.29	0.685	1.180	1.184	−0.337	1.27	1.16	1.161	−0.086
SO_2	Compression	I	290	9.76	1.2557	0.968	0.527	0.733	1.30	0.895	1.257	1.225	+2.612	1.18	1.14	1.1015	+3.495
	Compression	II	285	9.725	1.2569	0.962	0.1578	0.667	1.27	0.730	1.18	1.166	+1.200	1.23	1.14	1.130	+0.885
	Expansion	III	340	9.78	1.2551	1.032	0.527	0.617	1.30	0.810	1.23	1.185	+3.797	1.18	1.11	1.075	+3.256
	Expansion	IV	358	9.75	1.2560	1.006	0.1578	0.632	1.27	0.700	1.175	1.186	−0.927	1.23	1.13	1.128	+0.1773
CH_4	Compression	I	−115	7.70	1.3479	1.003	0.357	0.684	1.36	0.800	1.270	1.250	+1.600	1.33	1.24	1.187	+4.465
	Compression	II	− 25	8.10	1.3252	1.265	0.245	0.711	1.34	0.760	1.236	1.223	+1.062	1.30	1.195	1.197	−0.167
	Expansion	III	− 75	7.84	1.3396	1.12	0.357	0.536	1.35	0.700	1.22	1.218	+0.164	1.32	1.19	1.169	+1.796
	Expansion	IV	+ 14	8.24	1.3179	1.377	0.245	0.605	1.33	0.655	1.19	1.192	−0.167	1.30	1.16	1.173	−1.108
C_2H_4	Compression	I	80	10.43	1.2354	1.059	0.785	0.761	1.29	0.915	1.26	1.254	+0.478	1.135	1.10	1.105	−0.452
	Compression	II	170	11.79	1.2028	1.236	0.588	0.635	1.22	0.770	1.15	1.132	+2.473	1.17	1.11	1.103	+0.635
	Expansion	III	97	10.68	1.2286	1.092	0.785	0.698	1.28	0.860	1.23	1.230	0	1.14	1.09	1.098	−0.729
	Expansion	IV	225	12.43	1.1903	1.343	0.588	0.605	1.21	0.710	1.163	1.135	+2.466	1.15	1.11	1.090	+1.835
C_2H_6	Compression	I	90	12.80	1.1838	1.000	0.635	0.726	1.25	0.905	1.20	1.189	+0.925	1.055	1.03	1.060	−2.830
	Compression	II	280	15.95	1.1423	1.396	0.423	0.719	1.16	0.780	1.12	1.112	+0.719	1.11	1.08	1.080	0
	Expansion	III	130	13.47	1.1731	1.073	0.635	0.632	1.21	0.820	1.168	1.150	+1.565	1.09	1.06	1.046	+1.338
	Expansion	IV	319	16.58	1.1362	1.416	0.423	0.704	1.15	0.770	1.11	1.103	+0.634	1.09	1.06	1.076	−1.487
CH_3Cl	Compression	I	220	11.11	1.2179	0.910	0.1862	0.700	1.24	0.780	1.175	1.180	−0.423	1.175	1.11	1.113	−0.270
	Compression	II	178	10.71	1.2279	0.855	0.117	0.672	1.25	0.735	1.17	1.163	+0.601	1.19	1.11	1.1375	−2.418
	Expansion	III	248	11.37	1.2118	0.947	0.1862	0.692	1.23	0.765	1.164	1.167	−0.257	1.17	1.11	1.110	0
	Expansion	IV	252	11.40	1.2112	0.951	0.117	0.764	1.22	0.800	1.170	1.146	+2.094	1.19	1.14	1.119	+1.877
CCl_2F_2	Compression	I	150	18.85	1.1178	0.881	0.203	0.674	1.15	0.780	1.11	1.106	+0.361	1.02	1.01	1.030	−1.942
	Compression	II	275	20.81	1.1056	1.062	0.232	0.681	1.13	0.750	1.095	1.089	+0.550	1.02	1.01	1.050	−3.810
	Expansion	III	180	19.30	1.1148	0.919	0.203	0.702	1.14	0.785	1.105	1.101	+0.363	1.04	1.03	1.041	−1.057
	Expansion	IV	310	21.32	1.1028	1.112	0.232	0.588	1.11	0.660	1.07	1.075	−0.465	1.09	1.06	1.045	+1.435
$CHClF_2$	Compression	I	115	13.52	1.1723	0.864	0.206	0.684	1.22	0.79	1.165	1.150	+1.304	1.07	1.04	1.056	−1.515
	Compression	II	260	16.27	1.2400	1.082	0.216	0.680	1.25	0.74	1.175	1.113	+5.570	1.22	1.095	1.076	+1.766
	Expansion	III	151	13.96	1.1660	0.918	0.206	0.632	1.20	0.74	1.14	1.128	+1.063	1.09	1.05	1.054	−0.380
	Expansion	IV	308	15.89	1.1430	1.155	0.216	0.643	1.16	0.70	1.11	1.095	+1.369	1.09	1.06	1.071	−1.027
													avg. 1.17%				avg. 1.64%

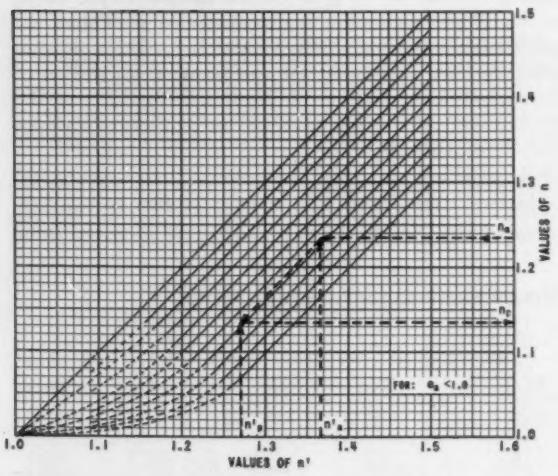


FIGURE 9.15—Guide lines for estimating polytropic volume change. Exponent for polytropic path, where $e_a < 1.0$.

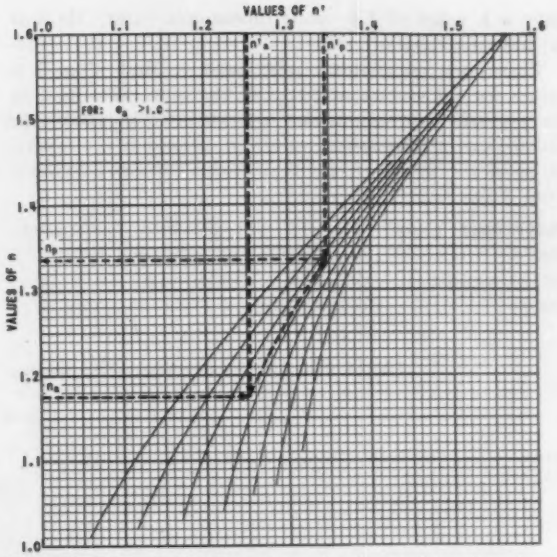


FIGURE 9.16—Guide lines for estimating polytropic volume change. Exponent for polytropic path, where $e_a > 1.0$.

TABLE 9.6 Demonstration of Exponent Prediction Methods for Polytropic Paths E (where $e_a > 1.0$)

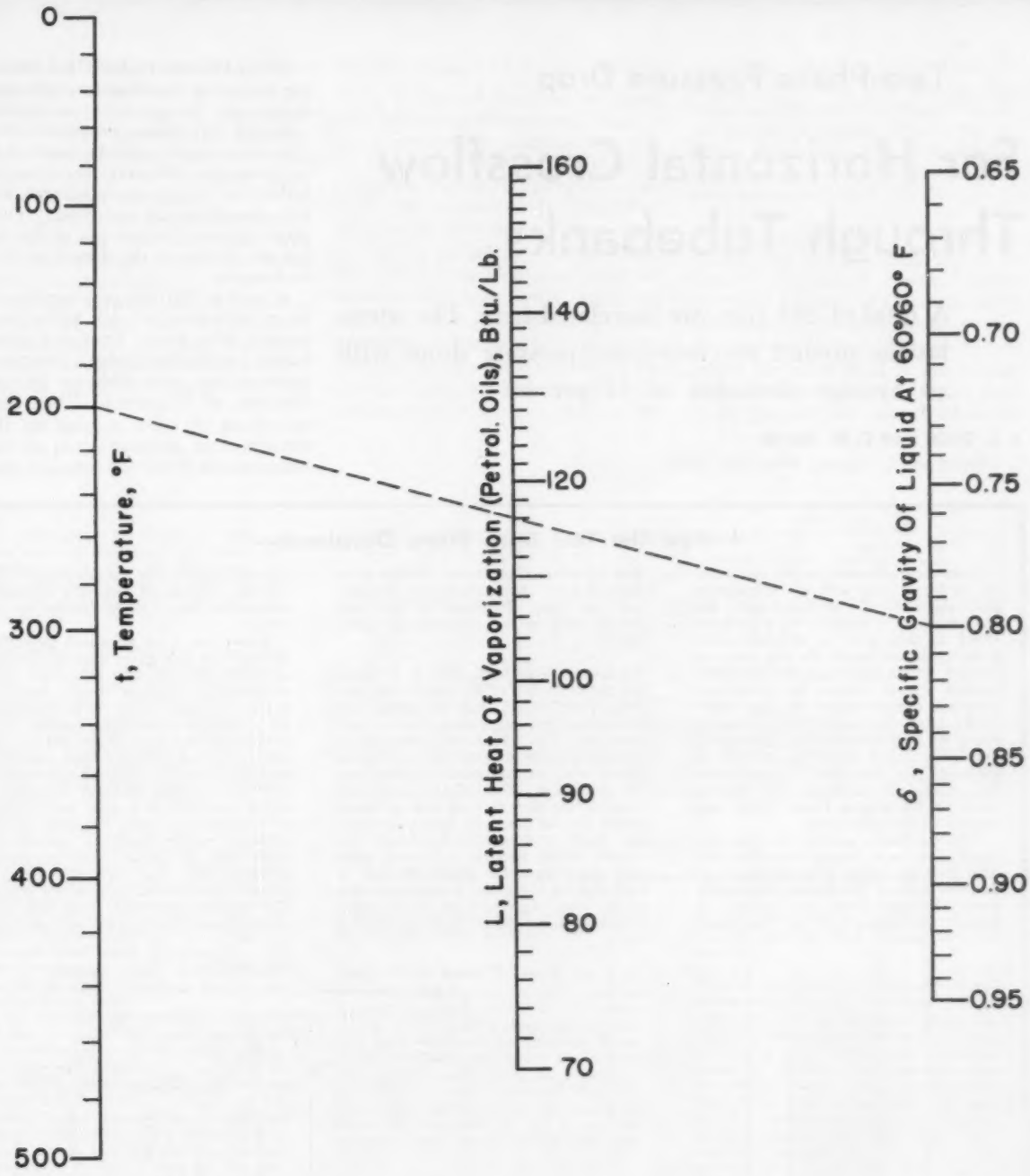
			Ideal Gas			Reduced Condition		Ad. Eff. e_a Table 8.6	TEMPERATURE EXPONENTS n'					VOLUME EXPONENT n			
Subs't	Operation	Group	T_{avg} °F	$C^{\circ}_{P_{mean}}$	k	$T_{r\,avg}$	$P_{r\,avg}$		Calc. n'_a Fig. 9.13	Poly Corr. Fig. 8.5	Calc. n'_p Fig. 8.6	Obs. n'_p Table 8.3	% Error	Calc. n_a Fig. 9.14	Calc. n_p Fig. 9.16	Obs. n_p Table 8.3	% Error
H_2O	Compression	I	785	8.94	1.2859	1.070	0.390	1.158	1.30	1.11	1.34	1.336	+0.299	1.265	1.33	1.336	−0.449
	Compression	II	750	8.90	1.2875	1.041	0.226	1.266	1.30	1.20	1.38	1.380	0	1.270	1.38	1.390	−0.719
	Expansion	III	713	8.82	1.2909	1.008	0.390	1.467	1.31	1.28	1.43	1.430	0	1.265	1.44	1.523	−5.450
	Expansion	IV	658	8.75	1.2939	0.961	0.226	1.116	1.30	1.085	1.33	1.339	−0.672	1.290	1.33	1.315	+1.141
NH_3	Compression	I	270	9.30	1.2718	1.000	0.042	1.214	1.28	1.205	1.36	1.3535	+0.480	1.250	1.36	1.340	+0.746
	Compression	II	205	9.02	1.2826	0.912	0.093	1.216	1.29	1.185	1.36	1.360	0	1.270	1.36	1.346	+1.040
	Expansion	III	224	9.09	1.2798	0.936	0.042	1.298	1.29	1.280	1.40	1.403	−0.213	1.260	1.40	1.400	0
	Expansion	IV	165	8.87	1.2888	0.856	0.093	1.149	1.29	1.125	1.34	1.340	0	1.280	1.34	1.340	0
SO_2	Compression	I	340	9.72	1.2570	1.033	0.527	1.362	1.29	1.185	1.36	1.336	+1.796	1.195	1.33	1.300	+2.308
	Compression	II	350	9.775	1.2552	1.045	0.1578	1.244	1.26	1.210	1.33	1.304	+1.993	1.245	1.33	1.292	+2.941
	Expansion	III	300	9.73	1.2567	0.981	0.527	1.160	1.30	1.070	1.32	1.301	+1.460	1.15	1.24	1.230	+0.813
	Expansion	IV	293	9.73	1.2567	0.973	0.1578	1.298	1.26	1.240	1.35	1.340	+0.746	1.25	1.37	1.334	+2.699
CH_4	Compression	I	−75	7.88	1.3373	1.120	0.357	1.314	1.35	1.230	1.47	1.455	+1.030	1.315	1.48	1.455	+1.718
	Compression	II	+5	8.26	1.3169	1.352	0.245	1.090	1.32	1.080	1.35	1.402	−3.708	1.305	1.35	1.395	−3.266
	Expansion	III	−110	7.66	1.3504	1.018	0.357	1.207	1.37	1.140	1.46	1.487	−1.815	1.325	1.46	1.490	−2.013
	Expansion	IV	−22	8.11	1.3246	1.276	0.245	1.290	1.33	1.240	1.445	1.466	−1.432	1.320	1.46	1.465	−0.341
C_2H_4	Compression	I	100	10.70	1.2281	1.098	0.785	1.436	1.28	1.200	1.355	1.354	+0.073	1.140	1.32	1.321	−0.076
	Compression	II	220	12.45	1.1900	1.335	0.588	1.349	1.21	1.265	1.28	1.249	+2.481	1.150	1.26	1.271	−0.865
	Expansion	III	77	10.40	1.2363	1.053	0.785	1.212	1.29	1.075	1.355	1.356	−0.073	1.12	1.31	1.325	−1.132
	Expansion	IV	185	12.10	1.1965	1.265	0.588	1.199	1.23	1.14	1.27	1.256	+1.114	1.13	1.22	1.223	−0.245
C_2H_6	Compression	I	115	13.21	1.1771	1.046	0.635	1.200	1.27	1.09	1.30	1.243	+4.585	1.00	1.15	1.162	−1.033
	Compression	II	315	16.53	1.1367	1.409	0.423	1.243	1.16	1.21	1.20	1.181	+1.608	1.06	1.15	1.160	−0.862
	Expansion	III	85	12.75	1.1847	0.991	0.635	1.303	1.25	1.10	1.28	1.289	−0.698	1.055	1.22	1.209	+0.910
	Expansion	IV	274	15.84	1.1435	1.334	0.423	1.358	1.16	1.285	1.215	1.215	0	1.10	1.19	1.222	−2.619
CH_3Cl	Compression	I	255	11.43	1.2105	0.957	0.1862	1.508	1.23	1.39	1.35	1.330	+1.503	1.17	1.35	1.311	−2.975
	Compression	II	264	11.51	1.2087	0.969	0.117	1.440	1.22	1.37	1.33	1.320	+0.757	1.19	1.33	1.330	0
	Expansion	III	218	11.10	1.2181	0.907	0.1862	1.335	1.24	1.255	1.32	1.321	−0.075	1.17	1.30	1.294	+0.464
	Expansion	IV	182	10.71	1.2279	0.858	0.117	1.209	1.25	1.17	1.305	1.338	−2.466	1.19	1.28	1.329	−3.687
CCl_2F_2	Compression	I	180	19.32	1.1147	0.924	0.203	1.323	1.14	1.24	1.186	1.172	+1.194	1.04	1.13	1.125	+0.444
	Compression	II	305	21.28	1.1030	1.105	0.232	1.323	1.11	1.26	1.140	1.151	−0.955	1.08	1.13	1.133	−0.265
	Expansion	III	150	18.85	1.1179	0.880	0.203	1.300	1.15	1.20	1.185	1.184	+0.084	1.02	1.12	1.125	−0.444
	Expansion	IV	275	20.77	1.1058	1.061	0.232	1.319	1.12	1.255	1.140	1.160	−1.724	1.06	1.14	1.133	−0.618
$CHClF_2$	Compression	I	150	13.85	1.1675	0.917	0.206	1.374	1.20	1.26	1.265	1.252	+1.038	1.10	1.22	1.199	+1.751
	Compression	II	300	15.77	1.1442	1.142	0.216	1.241	1.15	1.205	1.186	1.191	−0.503	1.13	1.18	1.171	+0.769
	Expansion	III	116	13.55	1.1719	0.866	0.206	1.273	1.20	1.175	1.245	1.195	+4.184	1.11	1.20	1.186	+1.180
	Expansion	IV	258	15.27	1.1496	1.078	0.216	1.345	1.16	1.275	1.21	1.151	+5.125	1.125	1.20	1.200	0
													avg. 1.28%				avg. 1.276%

Figures 9.13 and 9.14 and from the data on these same adiabatic and polytropic paths (i.e., Tables 8.1, 8.2, 8.3, 9.4, 9.5, and 9.6) used in the previous polytropic development. Figure 9.15 gives guide lines for estimating n_p from n'_a, n'_p, and n_a for polytropic paths having $e_a < 1.0$. Figure 9.16 gives guide lines for estimating n_p from n'_a, n'_p, and n_a for polytropic paths having $e_a > 1.0$.

It will be noted that the exponent scales on Figures 9.15 and 9.16 do not go below 1.0. Values of $n < 1.0$ are possible, as can be seen on Figure 9.14. This fact indicates that the guide lines in Figures 9.15 and 9.16 should have been drawn to less than unity n values. From the data available, this could not be done, however, so these charts should be regarded as tentative.

Comparisons of values of n_p found from Figures 9.14 and 9.15 or 9.16 with "observed" n_p values from Table 8.3 are given in Tables 9.5 and 9.6. Agreement is excellent.

Part 10 will appear in an early issue of PETROLEUM REFINER



Find Latent Heats Quickly

D. S. Davis
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FOR PETROLEUM OILS, the latent heat of vaporization, L, in Btu/lb, is given by the equation[1]

$$L = (110.9 - 0.09t)/\delta$$

where t = temperature in degrees Fahrenheit
and δ = specific gravity of the liquid at 60°/60° F.

This equation can be solved readily and accurately by means of the accompanying nomograph, which was constructed in accordance with well-known methods.[2] The broken line on the chart shows that the latent heat of vaporization of a petroleum oil with a specific gravity of 0.80 at 60/60 F is 116 Btu/lb when the temperature is 200 F.

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[1] Bureau of Standards Miscellaneous Publication No. 97 quoted in "Heat Exchanger Tube Manual," 3rd ed., p. 147, Scovil Manufacturing Co., Waterbury, Conn., 1957.

[2] Davis, D. S., "Nomography and Empirical Equations," Chap. 6, Reinhold Publishing Corporation, New York, 1955.

Two-Phase Pressure Drop . . .

For Horizontal Crossflow Through Tubebanks

A total of 283 runs are correlated here. The correlations predict the two-phase pressure drops with an average deviation of 12 percent

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TWO-PHASE PRESSURE DROP for horizontal crossflow through tubebanks can be predicted accurately with the correlations developed here. The correlations may be applied to condensers, reboilers, catalytic reformer and pretreater exchangers, and rich absorption oil pretreaters. Two-phase pressure drop is one of the important factors in the design of these exchangers.

A total of 283 test runs were made in an isothermal test unit and a heat-transfer pilot plant. Empirical correlations predict the adiabatic two-phase pressure-drop data with an average deviation of 12 percent. These correlations serve as a basis for the prediction of pressure drop during condensation. Predicted values of con-

—How the Test Data Were Obtained—

Data were obtained in two test units, an air-liquid unit and a condensation pilot plant. In the air-liquid unit, the test section was enclosed in a pressure vessel so that tests at different pressures could be made. In this unit we studied inline and staggered tubefield layouts. Figure 1 shows the layout and gives the dimensions of the four tubebanks tested. In the condensation pilot-plant, we gathered adiabatic two-phase data at different pressures, as well as pressure-drop data during condensation. Only the tubebank with ¾-inch tubes on 45 degree 1-inch pitch was studied in the pilot plant

The tubebanks studied in the air-liquid unit were dummy bundles with solid rods for tubes. The two faces at the tube ends of the dummy tubebanks were fabricated from clear plastic to permit observation of the two-phase flow patterns. The dummy bundle with ¾-inch tubes on 45 degree 1-inch pitch was an exact duplicate of the test bundle used in the condensation pilot plant.

Air-Liquid Test Unit. Figure 2 shows the arrangement of the tubebank, the circulating system, and the means for measuring flow rates, temperatures, and pressures. The air entered through a calming section to establish a uniform flow-pattern at the point of entry into the tubebank. The water entered through the first vertical row of tubes which formed a special liquid distributor Each tube of the distributor received liquid through a ⅜-inch tube and discharged the liquid through a row of holes along the downstream side of the tube. At very high liquid rates, a second spray head in front of the bundle delivered additional liquid. The mixture discharged from the tubebank above the liquid surge volume in the vessel.

Flow rates were measured by orifice meters with test gages used to measure upstream pressure and calibrated thermometers to measure stream temperatures. Pressure drops were measured by a special manometer system. The manometer manifold connected in parallel a 50-inch mercury-filled manometer, a 50-inch water-filled manometer, and an oil-filled inclined manometer which had a 20-inch scale and a range of 4 inches of water. A small air or nitrogen purge kept the manometer leads free of liquid. The measured pressure drop was corrected for any pressure differential due to the purge. The pressure-tap holes, 1/32-inch diameter, passed through the end plates of

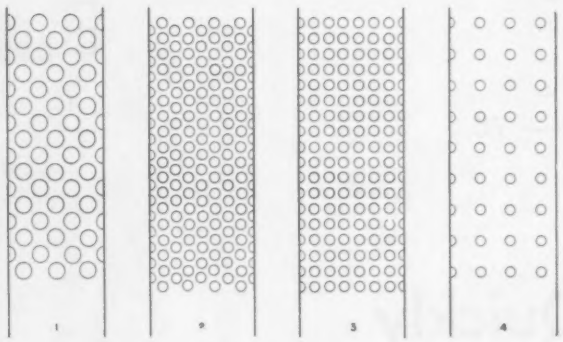


FIGURE 1—(Above left) Tubefields used in test units. Tubebank 1, ¾-inch tubes on 45-degree 1-inch pitch. Tubebank 2, ½-inch tubes on 60-degree ⅝-inch pitch. Tubebank 3, ½-inch tubes on 90-degree 1¼-inch pitch. Tube length is four inches.

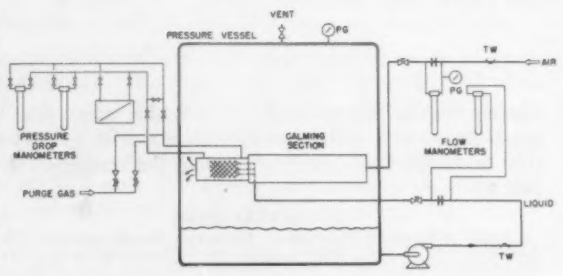


FIGURE 2—(Left) Flow diagram of unit for air-liquid tests.

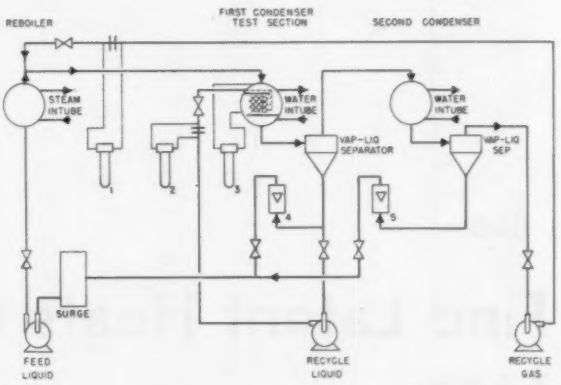


FIGURE 3—(Above) Flow diagram for two-phase tests and condensation tests with pentane in the condensation pilot plant.

densation. Predicted values of condensation pressure-drop deviate from test data by an average of 16 percent.

The inshell horizontal crossflow studies reported here were part of a larger program on two-phase flow.

(See Box Below)

Other portions of the program covering horizontal flow in pipes[2] and downflow through tubebanks[3] have been presented earlier.

Two-Phase Correlation. As reported earlier,[3] we were able to correlate pressure drop for two-phase downflow through horizontal tubebanks by plotting on logarithmic coordinates the ratio $\Delta P_{tp}/\Delta P_{G\theta}$ versus $LVF/[(\rho_G/\rho_L)(Re_{G\theta})^n]$.

For horizontal crossflow we found that the Reynolds-number, $Re_{G\theta}$, is not a correlating parameter. A plot of $\Delta P_{tp}/\Delta P_{G\theta}$ versus $LVF/(\rho_G/\rho_L)$ correlates the horizontal crossflow data. The pressure-drop ratio $\Delta P_{tp}/\Delta P_{G\theta}$ is the two-phase pressure drop divided by the all-gas pressure drop. The all-gas pressure drop is computed from the total mass flow of liquid and gas, $(W_L + W_G)$, and the physical properties of the gas. LVF is the superficial liquid volume fraction of the mixture computed from the flow rates and densities of the two phases. The superficial LVF can differ from the actual LVF since the phases may travel at different velocities. The all-gas Reynolds number, $Re_{G\theta}$ is the fictitious single-phase Reynolds number based on the total mass flow and the physical properties of the gas.

Tubebank Correlations. The final correlations of the test data appear in Figures 5 through 8. Figure 5 shows the data for the staggered tube arrangement, ¾-inch tubes on 45-degree, 1-inch pitch. The curve correlates air-water data at one atmosphere and pentane vapor-liquid data at 65 psia with an average deviation

the tubebanks. All burrs or obstructions which might distort the flow across the hole were carefully eliminated. A given pressure in the pressure vessel could be maintained by adjusting the vent valve.

Pilot Plant. Two types of tests were made with the pentane vapor-liquid system in the condensation pilot plant —adiabatic two-phase pressure-drop tests and condensation pressure-drop tests. Figure 3 gives a schematic flow diagram. Standard orifice meter runs, 1 and 2 in Figure 3, were used to meter the recycle stream rates. Calibrated rotameters, 4 and 5 in Figure 3, were used to measure vapors condensed in the test bundle and in the second condenser. The sum of the rotameter readings was checked by heat balance against the steam condensed in the reboiler tubes. Temperatures were measured by calibrated thermocouples, and pressures were indicated by test gages. Pressure-drops were measured by the same manometer board, 3 in Figure 3, and by the same techniques used in the air-liquid test unit.

For the adiabatic two-phase tests, the reboiler generated the vapor phase. The vapor flowed through the test section in the first condenser and condensed in the second condenser. The tube surface in the first condenser was held at the reboiler vapor temperature to prevent vapor condensation. The liquid entered the tubebank through the same special distributor as described for the air-liquid test unit. From the first condenser test section, the liquid phase recycled through the liquid recycle system.

In the pilot plant, we also made condensation pressure-drop measurements with the pentane system at about 65 psia. Different fractions of the vapor from the reboiler condensed in the first condenser, depending upon the temperature of the water flowing through the tubes.

TESTS

Three types of tests were made —single-phase calibration tests, adiabatic two-phase pressure drop tests, and condensation pressure-drop tests. The single-phase calibration tests and the adiabatic two-phase pressure-drop tests were made in both test units. The condensation pressure-drop tests were made in the pilot plant tubebank only.

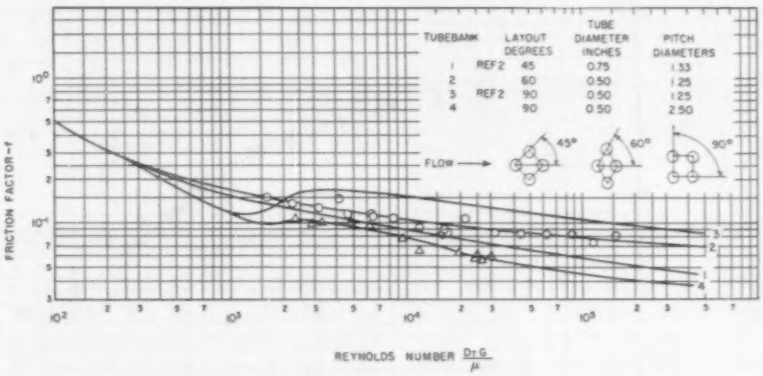


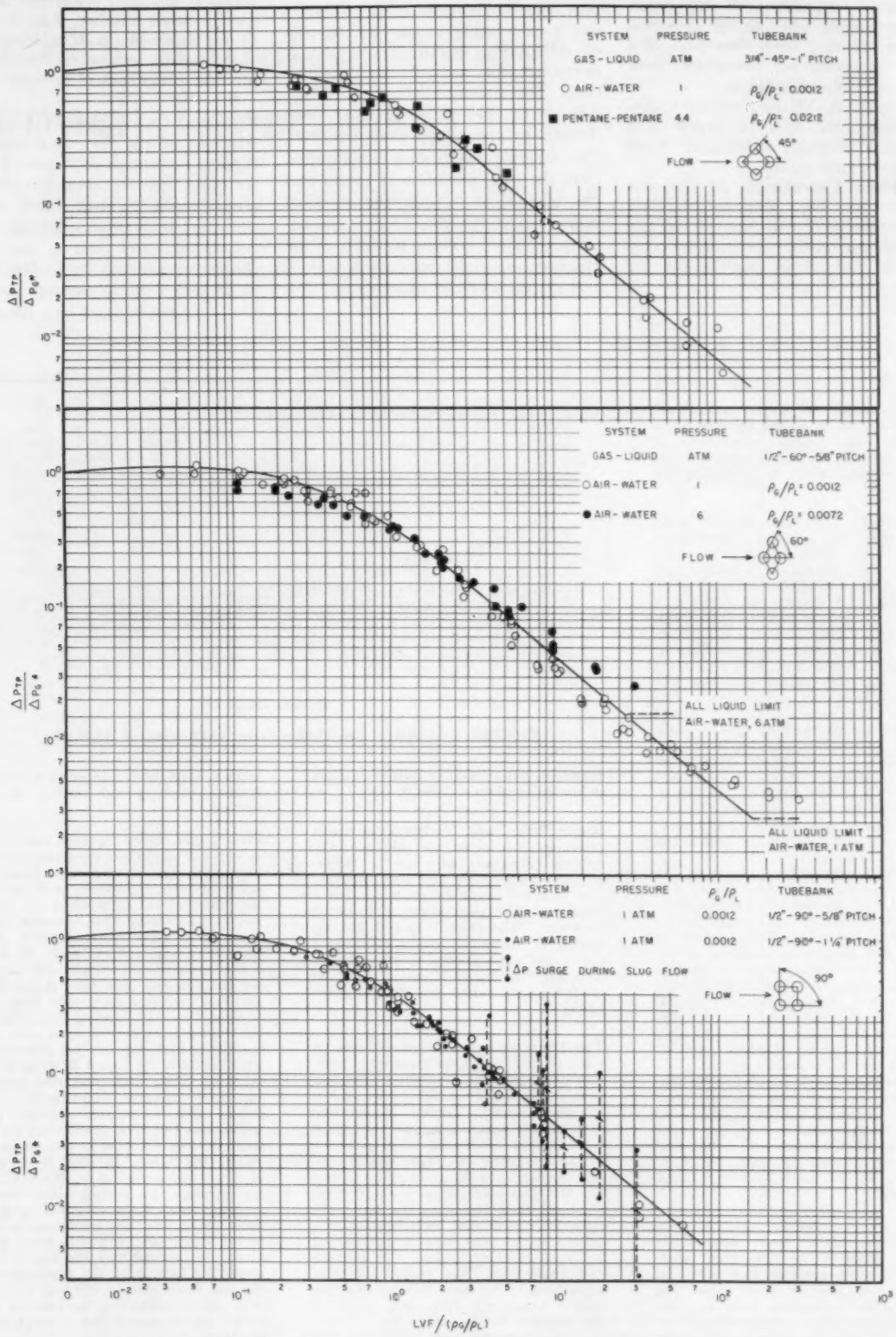
FIGURE 4—Single phase friction factor calibration of tubebanks.

Single-Phase Tests. To check the single phase friction factor, we calibrated the dummy tubebanks with air at atmospheric pressure. We also used methane and pentane vapor to calibrate Tubebank 1 in the pilot plant. Calibration data for Tubebanks 1 and 3 are reported in an earlier paper.[3] Figure 4 shows the experimental friction factor data for Tubebanks 2 and 4, and the friction-factor curves for all four tubebanks.

Two-Phase and Condensation Tests. A total of 267 adiabatic two-phase pressure-drop tests in horizontal crossflow were made in the air-liquid unit and in the pilot plant. Another 16 pressure drop tests were made in the pilot plant for crossflow condensation of pentane.

The operating procedure was in general the same for the air-liquid test unit and the pilot plant. After the unit came to steady state operation the data were recorded for the test. Steady state conditions in the pilot plant were checked by heat balance around the reboiler and condensers. We considered data acceptable if the heat balance checked within 5 percent. The data included the pressure at the exit of the test section, the pressure drop across the test section, and the temperature of the streams entering and leaving the test section.

Flow Types. Alves[1] reported and roughly defined conditions for seven types of two-phase flow in horizontal pipes. In order of their appearance with increasing liquid flow, these types are designated as misting flow, annular flow, slug flow, wavy flow, layered flow, plug flow, and bubble flow. In horizontal crossflow through tubebanks, we encountered only four types, misting flow, annular flow, slug flow, and layered flow. In misting flow most of the liquid is entrained as a mist carried by a high velocity gas stream. In annular flow, the liquid flows as a film over the tubes and from one tube to the tube directly downstream. The tubes offer a support surface over which the liquid is distributed by the high velocity gas flow in the spaces between the tubes. In slug flow, slugs of liquid are propelled by the gas flowing through the system. The flow is unsteady with large surges in pressure drop. Slug flow was encountered only in the inline tubebank with large pitch ratio. In layered flow the liquid flows along the bottom of the tubebank and the gas flows above. All four types of flow are correlated by the method presented for horizontal flow through tubebanks.



FIGURES 5, 6 and 7—Correlation of 2-phase pressure drop for turbulent horizontal crossflow through tubebank. Figure 5 with 45 layout, Figure 6 with 60 layout and Figure 7 with inline layout.

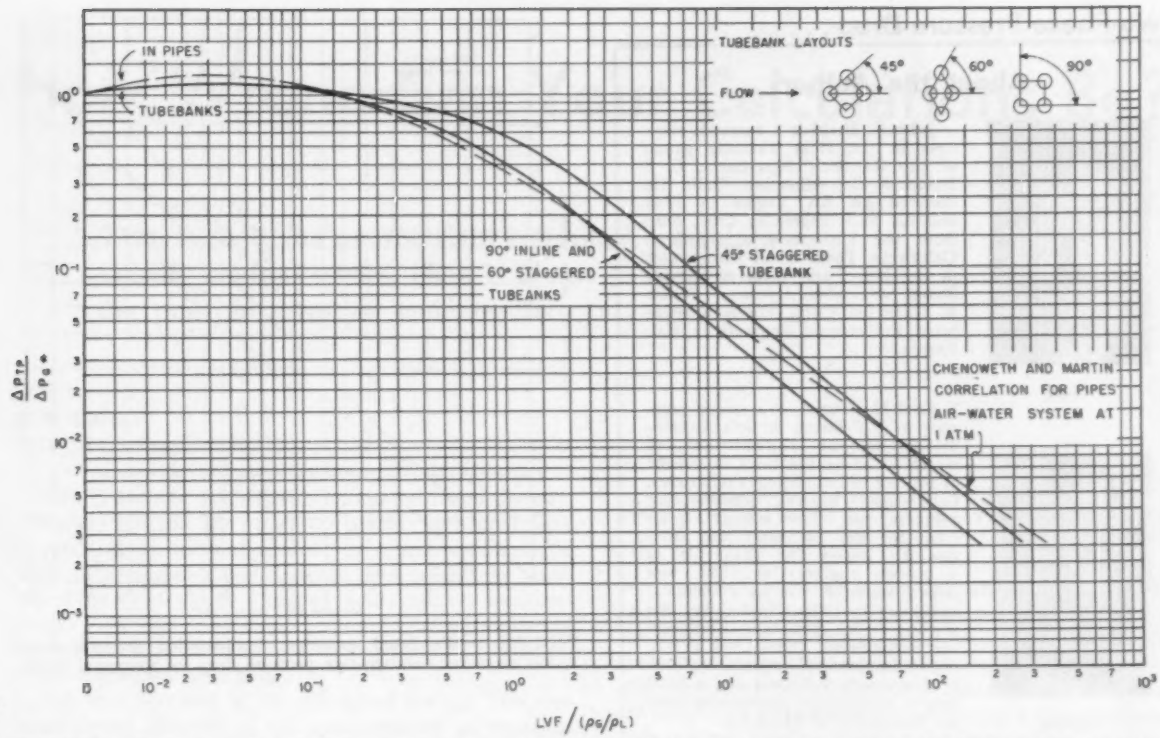


FIGURE 8—Comparison of two-phase pressure-drop correlations for turbulent horizontal flow through tubebanks and inside pipes.

of 13 percent. Nine tenths of the tests fall within a maximum deviation of plus or minus 20 percent of the curve value. We secure a tie-in point with the single phase gas pressure drop when LVF = O and $\Delta P_{tp}/\Delta P_{G*} = 1$. To plot the zero value of the abscissa on logarithmic coordinates, we subtract the lowest abscissa value, 10^{-2}, from the abscissa scale. This makes the low end of the scale converge such that zero appears at normal position of 1×10^{-2}, 1×10^{-2} appears at the normal position of 2×10^{-2} and 1×10^{-1} appears at the normal 1.1×10^{-1}. At abscissa scale values greater than 1×10^{0} the significance of the subtraction disappears.

Figure 6 shows the data for the tubebank with ½-inch tubes on 60-degree, ⅝-inch pitch. The curve correlates air-water data at one and six atmospheres pressure with an average deviation of 12 percent. Three fourths of the tests fall within a maximum deviation of plus or minus 20 percent of the curve value, and nine tenths of the tests fall within 30 percent.

Figure 7 shows the data for two inline tubebanks, one with ½-inch tubes on 90-degree ⅝-inch pitch and the other ½-inch tubes on 90-degree 1¼-inch pitch. The curve correlates air-water data at one atmosphere pressure in both tubebanks with an average deviation of 10 percent. Nine tenths of the tests fall within a maximum deviation of plus or minus 20 percent of the curve value. Slug flow was encountered most markedly in the inline tubefield with 1¼-inch pitch. The pressure-drop surges occurred at high liquid to gas rates. The measured pressure drop during surge would sometimes cover a ten fold range from minimum to maximum, as shown on Figure 7. The average pressure drop during slug flow is indicated on the figure by the midpoint mark on the pressure-drop surge line. The tests with the other more common pitch ratios indicated that slug flow is minimized by close tube spacing.

Figure 8 shows the correlating curves from Figures 5, 6, and 7. We see that the data for inline or 90-degree layouts and the 60-degree triangular layout is correlated by the same single curve. The curve for the 45-degree layout lies above the inline curve. All the tubebank curves merge at abscissa values below 0.1. Also shown on Figure 8 is the curve for the air-water system at one atmosphere flowing in horizontal pipes. Values for this curve were computed using the correlation of Chenoweth and Martin[2]. We make this comparison since the same basic parameters are used in the correlations for two-phase horizontal flow in pipes and in tubefields. The curve for two-phase flow through inline tubefields and through pipes are in rather close agreement over most of the range but begin to diverge at abscissa values greater than about 4.

CONDENSATION PRESSURE DROP

The two-phase correlations developed in Figures 5, 6, and 7 are based on tests with no change in the ratio of the phases. In a condenser, the ratio of gas to liquid continuously decreases as the vapor is condensed. And the pressure drop per unit length of travel decreases. Use of the correlations in computing pressure drop during condensation requires a summation of point values from inlet to outlet.

We have computed the pressure drop for 16 condensation tests with pentane in the pilot plant and have compared the results with measured values in Figure 9. Predicted values agree with the test data with a maximum deviation of plus or minus 30 percent and an average deviation of 16 percent.

About the Authors

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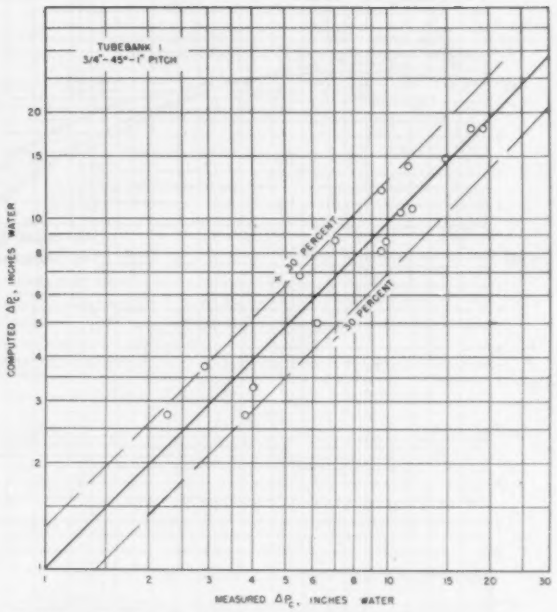

FIGURE 9—Predicted crossflow condensation pressure drop versus measured condensation pressure drop for staggered tubes.

Accuracy and Limitations. A study of Figures 5, 6, and 7 show that 90 percent of 267 tests with systems having low liquid viscosities are correlated within a maximum deviation of plus or minus 24 percent. The average deviation of all the test points from the values predicted by the correlating curves is 12 percent.

The correlations apply to two-phase gas-liquid mixtures when the flow of gas phase is turbulent, $Re_G \geq 5{,}000$. Below this value the correlation will predict values that are too high.

When the flow is all gas and the abscissa equals zero, the correlation predicts a value of 1 for $\Delta P_{tp}/\Delta P_{G*}$. This is the single-phase gas pressure drop. At the other end of the correlation when the flow is all liquid, Equation 1 defines the lower limit for $\Delta P_{tp}/\Delta P_{G*}$.

$$\Delta P_{tp}/\Delta P_{G*} = \Delta P_L/\Delta P_{G*} = (\rho_G/\rho_L)\,(\mu_L/\mu_O)^{0.18} \qquad (1)$$

This all-liquid limit is shown in Figure 6 for the air-water system at one atmosphere where $(\rho_G/\rho_L)\,(\mu_G/\mu_L)^{0.18} = 0.0027$ and at six atmospheres where the value is 0.0162. The data points in this region break away from the correlating curve to approach the limiting value given by Equation (1).

SUMMARY

1. Gas-liquid two-phase pressure drops have been measured over a wide range of flow conditions for horizontal flow through four horizontal tubebanks. Two staggered arrangements are —¾-inch tubes on 45 degree 1-inch and ½-inch tubes on 60-degree ⅝-inch pitch. Two inline arrangements are —½-inch tubes on 90-degree ⅝-inch pitch and ½-inch tubes on 90-degree 1¼-inch pitch.

2. The correlations developed represent all of the data within a maximum deviation of plus or minus 35 percent, and nine tenths of the data within a maximum deviation of plus or minus 24 percent. The average deviation is 12 percent.

3. The data for the inline 90 degree layout and for the triangular 60-degree layout are correlated by the same curve. The staggered 45-degree layout has higher two-phase pressure drop ratio and the correlating curve lies above the curve for the inline arrangement.

4. Over a fairly wide range of flow conditions the two-phase pressure-drop for the inline arrangements could be predicted by the Chenoweth-Martin correlation[2] for two-phase flow in pipes.

5. Condensation pressure drop can be predicted by a stepwise computation using the two-phase correlation. Condensation test data are predicted within a maximum deviation of plus or minus 30 percent. The average deviation is 16 percent.

This paper was presented at the Second National Conference on Heat Transfer, sponsored jointly by ASME and AIChE in Chicago, August 19, 1958.

NOMENCLATURE

D — Tube outside diameter, ft
f — Friction factor, $f = \frac{2g\,\rho\,\Delta P}{4G^2\,N}$, dimensionless
g — Acceleration constant due to gravity, ft/sec²
G — Mass flow rate, based on the tubebank minimum crossflow area, lb/hr ft²
N — Number of restrictions encountered in flow through the tubebank
Re — Reynolds number, $Re = DG/\mu$, dimensionless
W — Flow rate of fluid, lb/hr
ΔP — Pressure-drop, lb/ft² or inches of water
μ — Viscosity, lb/ft hr
ρ — Density, lb/ft³

Subscripts

G — Gas phase
G* — Fictitious total flow as a gas
L — Liquid phase
tp — Two-phase

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[3] Diehl, J. E. *Petroleum Refiner*, 36, 147 (Oct. 1957)

How Wrong Can Your Calculations Be?

Even though you use the right equations, your data usually contain errors. Here is a way to determine the possible error of your results

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SOME MEASUREMENTS cannot be made directly. They are not like the length of a table measured with a yardstick or the temperature of a reactor measured with a thermometer. For example, determining the number of moles of gas in a reactor is an indirect measurement. First the temperature, pressure, and volume of the reactor may be measured, and the number of moles of gas calculated from these.

But how accurate is the calculated result? The separate errors inherent in the measurements of temperature, pressure, and volume will contribute to the error in the calculated number of moles. How can we estimate the over-all effect of these separate errors?

A method known as *propagation of error* can be used to estimate errors. The equation for this method is subject to the restriction that the errors of the measured quantities must be independent of each other. This means the method chosen for measurement of any quantity must not influence the result obtained when measuring any of the other quantities. For example, if the temperature is measured by means of a thermometer and the pressure by means of a gage, the measurements are independent and so are the errors. But if the pressure is calculated from the temperature, then the errors associated with the two quantities are related and the propagation equation, as shown, does not apply.

No derivation of the equation or discussion of error theory is given here because these subjects are covered in the literature.[1,2,3,4,5,6] A good discussion of the sources of experimental error is given by Kolthoff and Sandell.[7]

THE EQUATION

When a quantity is calculated as a function of several measured quantities, the result can be expressed in the following general form:

$$Q = f(q_1, q_2, \ldots, q_n)$$

where Q = calculated quantity
q_1, q_2, q_n = measured quantities
f = any function of $q_1, q_2, \ldots, q_n$

The total differential, dQ, is

$$dQ = \left(\frac{\partial Q}{\partial q_1}\right) dq_1 + \left(\frac{\partial Q}{\partial q_2}\right) dq_2 + \ldots + \left(\frac{\partial Q}{\partial q_n}\right) dq_n$$

Squaring both sides but dropping all the cross products on the right-hand side of the equation, we get

$$(dQ)^2 = \left(\frac{\partial Q}{\partial q_1}\right)^2 (dq_1)^2 + \left(\frac{\partial Q}{\partial q_2}\right)^2 (dq_2)^2 + \ldots + \left(\frac{\partial Q}{\partial q_n}\right)^2 (dq_n)^2 \quad (1)$$

which is one form of the propagation equation. The justification for dropping the cross products is given in the literature.[2,4] In this equation the differentials represent error in the measured quantities. A convenient and widely-used measure of error is the standard deviation. By substituting standard deviations (s) for the differentials, we get another form of the propagation equation.

$$(s_Q)^2 = \left(\frac{\partial Q}{\partial q_1}\right)^2 (s_{q_1})^2 + \left(\frac{\partial Q}{\partial q_2}\right)^2 (s_{q_2})^2 + \ldots + \left(\frac{\partial Q}{\partial q_n}\right) (s_{q_n})^2 \quad (2)$$

The two forms, (1) and (2), are equivalent general expressions for the propagation of error. The method for obtaining these expressions is not mathematically rigorous but serves as a simple memory system for recalling the correct form of the propagation equations.

EXAMPLES

1. We desire to calculate the number of moles of gas in a reactor and to estimate the standard deviation of the calculated quantity, using the perfect-gas law

$$N = \frac{PV}{RT}$$

Take These Steps to Find the Standard Deviation of Your Results:

- **Write the equation used to obtain the calculated result.**
- **Apply Equation (2) by finding the partial derivatives in terms of the original equation.**
- **Substitute standard deviations for the differentials.**
- **Evaluate the resulting equation and take the square root. This is the standard deviation sought.**

where P = pressure = 2.000 atmospheres with a standard deviation $s_P = 0.023$ atm.
V = volume = 100,000 ml with a standard deviation $s_V = 450$ ml
T = temperature = 300.0° K with a standard deviation $s_T = 1.0°$ K
R = the gas constant = 82.06 $\frac{\text{(ml) (atm)}}{\text{(°K) (gm mole)}}$

The number of moles of gas is

$$N = \frac{(2.000 \text{ atm})\ (100{,}000 \text{ ml})}{(82.06)\ (300.0° \text{ K})} = 8.12 \text{ gm moles}$$

To estimate the standard deviation of N, we make use of the propagation equation in form (1).

$$(dN)^2 = \left(\frac{\partial N}{\partial P}\right)^2 (dP)^2 + \left(\frac{\partial N}{\partial V}\right)^2 (dV)^2 + \left(\frac{\partial N}{\partial T}\right)^2 (dT)^2$$

Finding the partial derivatives and substituting standard deviations for the differentials, we obtain an equation similar to form (2), which can be evaluated.

$$(s_N)^2 = \left(\frac{V}{RT}\right)^2 (s_P)^2 + \left(\frac{P}{RT}\right)^2 (s_V)^2 + \left(\frac{-PV}{RT^2}\right)^2 (s_T)^2$$

$$= \left[\frac{100{,}000}{(82.06)\ (300.0)}\right]^2 (0.023)^2 + \left[\frac{2.000}{(82.06)\ (300.0)}\right]^2 (450)^2 + \left[\frac{(2.000)\ (100{,}000)}{(82.06)\ (300.0)^2}\right]^2 (1.0)^2$$

$$= 0.01080$$

$s_N = \sqrt{0.01080} = \pm 0.10$ gm moles. (To two significant figures.)

2. Calculate the quantity of gas produced by a catalytic cracking plant and estimate the standard deviation of the result, using the following material-balance equation:

$$G = Ff - Pp - C$$

where G = quantity of gas in lb/hr
F = feed rate = 1,000 bbl/hr, with $s_F = 10$ bbl/hr
quantity of gas in lb/hr
f = feed gravity = 25.0° API or (350.1) (0.9042) = 316.6 lb/bbl, with $s_f = 0.40°$ API or 0.82 lb/bbl
P = total liquid product = 750 bbl/hr, with $s_P = 10$ bbl/hr
p = liquid-product gravity = 33.0° API or (350.1) (0.8602) = 301.2 lb/bbl with $s_p = 0.30°$API or 0.56 lb/bbl
C = coke yield = 16,000 lb/hr, with $s_C = 800$ lb/hr

The quantity of gas produced is

$$G = (1{,}000)\ (316.6) - (750)\ (301.2) - 16{,}000 = 74{,}700 \text{ lb/hr}$$

To find the standard deviation of G, use form (1) of the propagation equation:

$$(dG)^2 = \left(\frac{\partial G}{\partial F}\right)^2 (dF)^2 + \left(\frac{\partial G}{\partial f}\right)^2 (df)^2 + \left(\frac{\partial G}{\partial P}\right)^2 (dP)^2 + \left(\frac{\partial G}{\partial p}\right)^2 (dp)^2 + \left(\frac{\partial G}{\partial C}\right)^2 (dC)^2$$

Find the partial derivatives and substitute standard deviations for the differentials to obtain an equation similar to form (2) of the propagation equation, which can be evaluated:

$$(s_G)^2 = f^2(s_F)^2 + F^2(s_f)^2 + (-p)^2(s_P)^2 + (-P)^2(s_p)^2 + (-1)^2(s_C)^2$$
$$= (316.6)^2(10)^2 + (1{,}000)^2(0.82)^2 + (301.2)^2(10)^2 + (750)^2(0.56)^2 + (800)^2$$
$$= 20{,}584{,}500$$

$s_G = \sqrt{20{,}584{,}500} = \pm 4{,}500$ lb/hr (To two significant figures.)

Up to now nothing has been said about the method of calculating the standard deviations s_f, s_F, etc. It was mentioned earlier that the errors in the measured quantities must be independent of each other. This does not mean that the measured quantities themselves need be independent of each other. In Example 2 above, the quantities f, F, p, P, C, and G are not independent since a change in any one of them would result in a change in one or more of the others. "For example, a change in the feed gravity f would most likely result in a change in the liquid-product gravity p." However, if several samples of liquid product are drawn in rapid succession so that no appreciable change in gravity occurs between the first and last sample, the variation in the set of values found for P will be due to sampling and analytical errors only since no change in f occurred in the short time required to take the set.

The standard deviations s_F and s_P can be kept independent of each other if we take them to be equal to the precision of the flow meters used to measure F and P, respectively, because they will then contain only random instrument error and will not be linked by error due to variations in flow rates. Determination of the coke yield C involves catalyst flow rate and carbon content of spent and regenerated catalyst; therefore, the standard deviation s_C contains instrument error plus sampling and analytical error. The precautions already described in drawing feed and product samples for gravity measurements must, of course, be observed in drawing samples of spent and regenerated catalyst for carbon analysis.

The estimated error s_G is then the standard deviation in the yield of gas G attributable to observational errors in the determination of F, f, P, p, and C.

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Heat Transfer Nomographs

PART 1: Velocity of liquids and gases in tubes

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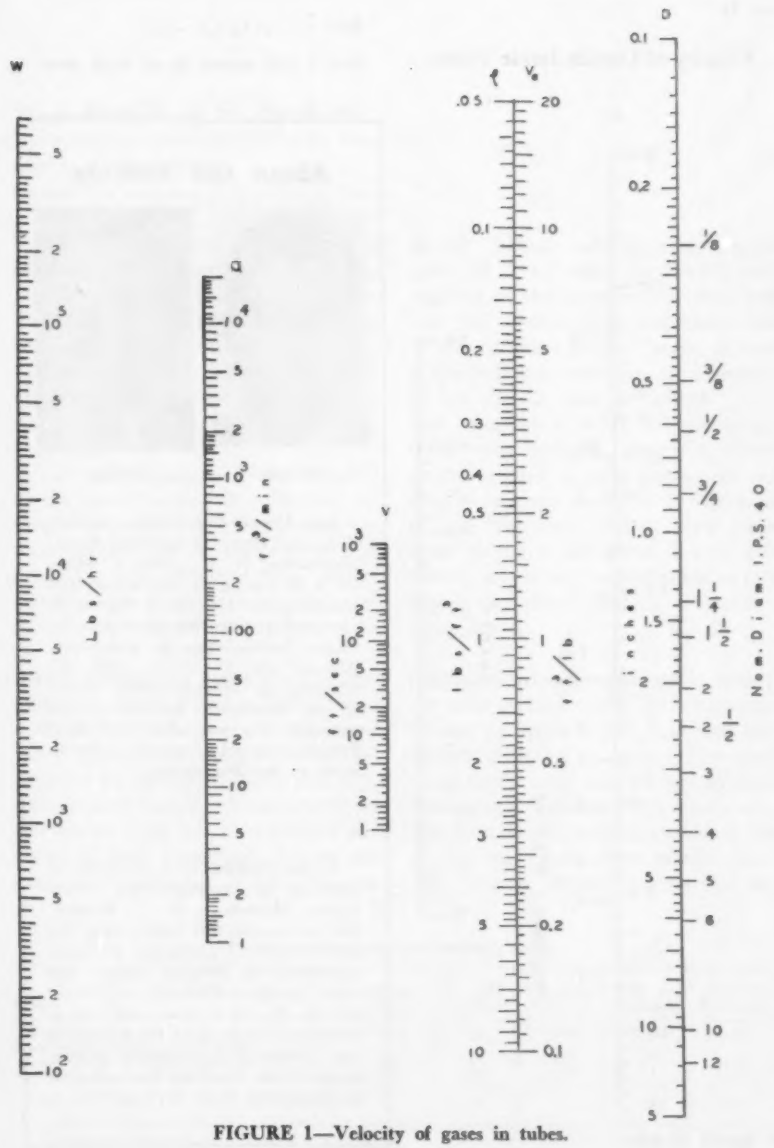

FIGURE 1—Velocity of gases in tubes.

This series of nomographs, beginning in this issue, are useful in heat transfer and flow calculations. The complete bibliography will appear in the final article.

IN THE FIELD of heat transfer, a great number of empirical equations are frequently used to calculate various coefficients. The calculation by simple numerical substitution is tiresome, and because of the great number of operations involved, subject to errors. The use of nomographs helps obtain quicker results, especially if fractional powers are involved.

Most nomographs are construed involving many simplifications. These nomographs are only useful for the limited field for which they are intended and large errors are involved when used beyond these limits. The nomographs presented in this series were constructed to use the most general equations and to cover a wide scope.

So that the use of these nomographs could be made as general as possible, separate nomographs were constructed for several dimensionless factors that frequently appear in the heat transfer equations such as the Reynolds number, Nusselt number, Prandtl number etc. Nomographs for the specific cases involved in heat transfer operations were constructed, using these dimensionless numbers.

At first glance this might appear complicated, because in finding a single coefficient several nomographs would have to be used instead of only one. However, with this system, it is possible to use the general equations, eliminating many restrictions; in this way, with a little more work, the de-

signer can be sure that the only error involved is the natural error in reading the scales, and can rely upon the basic equations used in the construction of the nomographs.

Some of the nomographs to be presented do not involve heat transfer, but are useful for calculating Reynolds number.

Velocity of Gases Inside Tubes—Nomograph No. 1 solves the formulas:

$$v = \frac{w}{S\rho} = \frac{4 \cdot 144\, w'}{3600\, \pi\, D'^2 \rho} = 0.0509\, \frac{w}{D'^2 \rho}$$

$$w = 60\, \rho\, Q$$

Where: v, velocity of gases inside the tubes, ft./sec.
w', flow in lb/hr.
ρ, density of the gas, at temperature and pressure inside the tube, lb/cu. ft.
Q, flow, cu. ft./min.
D', inside diameter, inches
S, cross-section of the tube, square feet.

Example: Find the velocity of air flowing at 500 lb./hr., 90 F and 50 psia, in a ¾ inch IPS 40 standard pipe.

Solution: Using Nomograph No. 1, it is found that v = 1150 ft./sec.

Key: w — ρ: Q; Q — D: v

With Nomograph No. 3 (to be published in Part 2) it could be found that the air density was 0.245 lb./cu. ft.

Velocity of Liquids Inside Tubes—Nomograph No. 2 solves the equations:

$$w = \frac{60}{7.48}\, Q\, \rho = 8.02\, Q\, \rho$$

$$v = \left(\frac{Q}{60 \cdot 7.48}\right)\left(\frac{4 \cdot 144}{\pi\, D'^2}\right) = 0.408\, \frac{Q}{D'^2}$$

Where: v, w, D' and ρ same as above
Q, flow, in GPM

Example: Find the velocity in ft./sec. of 10,000 lb./hr. of water at 100 F. flowing through a 2-inch standard pipe.

$$\rho = 62 \text{ lb./cu. ft.}$$

Solution: Using Nomograph No. 2 velocity is found to be 1.9 ft./sec.

Key: w — ρ: Q; Q — D: v

Part 2 will appear in an early issue.

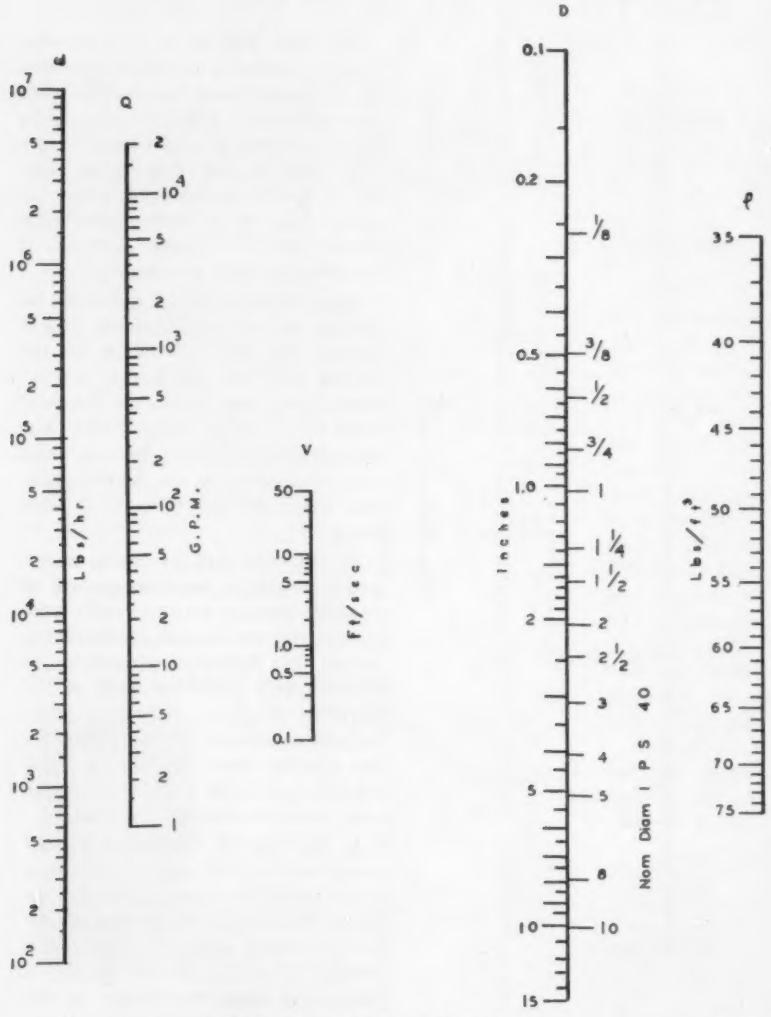

FIGURE 2—Velocity of liquids in tubes.

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What It Costs to Operate a Unifiner

Here are direct operating cost data on four typical Unifining units. The units vary in size, use and location to cover a wide range of application

W. J. Baral, G. E. W. Hendricks
Union Oil Company of California, Brea, Calif.
and L. R. Damskey
Union Oil Company of California, Rodeo, Calif.

AN OPERATING ANALYSIS of four typical Unifining units confirms the low costs predicted in 1954-55. The study particularly accentuates the low cost of catalyst for the Unifining process, especially when comparisons are made with other commonly used catalytic refining processes.

The units analyzed were designed to the specific needs of individual refiners and cover a variety of common applications of this process. The cost data were obtained from several refiners who operate units and represent their experience to date.

Direct operating costs for the four plants are summarized in Table 1 and compared with predictions of several years ago. Total costs from actual practice for operating labor and supplies, maintenance, utilities and catalyst range from 4.5 to 8.9 cents per barrel of feed. Predicted costs on the same basis were 6.5 to 9.2 cents per barrel. Actual catalyst costs range from 0.8 to 1.2 cents per barrel; and in three of the commercial units this cost will decline with continued use of the current catalyst charge. It was predicted that catalyst costs would be less than 2 cents per barrel.

A comparison of Unifining catalyst costs with catalyst costs for other processes used in most petroleum refineries is given in Table 2. Whereas typical Unifining catalyst costs have been shown to be about 1 cent per barrel of feed and are expected to fall lower, the other catalysts cost many times more.

Unifining was developed to satisfy the need of the refiner for a low-cost process to upgrade marginal and low quality distillate stocks. The first commercial unit started up in December, 1953—almost 4½ years ago. The first formal announcement of the process was made a few months later —in March, 1954.[1] During the ensuing four years the Unifining process was widely accepted by the petroleum industry.

Current commercial Unifining operations include mild treatment of naphthas, solvents and kerosines for color and stability improvement; pretreating of reformer feeds; finishing of stove oils, diesel fuels and burner oils; and upgrading of catalytic cracker feeds. Many of the units are in blocked operation, processing two or more feedstocks. Several refineries contain two or more Unifining units. In most plants process hydrogen is supplied by catalytic reformers. In some cases manufactured hydrogen is also used.

The widespread acceptance of the Unifining process is largely due to low operating costs and the exceptional performance and life characteristics of the Unifining catalyst. Its physical ruggedness, resistance to common catalyst poisons, and thermal stability result in long catalyst life

TABLE 1—Summary of Unifining Costs

FEED	Reformer Feed	Stove Oil and Diesel	Wide-Range Distillate	No. 2 Heating Oil	1954-1955 Predictions
Throughput, bpd	16,000	900	5,000	12,000	5,000
Direct Operating Costs, cents per barrel:					
Labor and Supplies, Maintenance, Utilities	6.3	3.7	5.7	7.7	4.5-7.2
Catalyst	0.9*	0.8*	0.8*	1.2	<2.0
Total	7.2	4.5	6.5	8.9	6.5-9.2

* Original catalyst still in service. Cost based on life to date.

TABLE 2—Typical Catalyst Costs

PROCESS	Catalyst Cost
Unifining, cents per barrel feed	1
Reforming (Pt), cents per barrel feed	5-15
Catalytic Cracking, cents per barrel feed	3-6
Alkylation (HF), cents per barrel alkylate	4-7
Alkylation (H_2SO_4), cents per barrel alkylate	15-30
Butane Isomerization, cents per barrel isobutane	3-7

with corresponding low catalyst costs per barrel of feed processed. This was predicted four years ago;[1] it has since been demonstrated in numerous commercial operations.

COST BASIS

In papers presented before the Western Petroleum Refiners Association in March, 1954, and the American Petroleum Institute in May, 1955, Unifining operating costs were predicted for moderate-sized units designed for a variety of applications.[1, 2] Today there are a large number of Unifining units that have been in service long enough to establish reliable cost information under refinery operating conditions.

Direct operating costs have been analyzed from four typical units, each in a different service and a different refinery. The plants studied were designed to fulfill the needs and practices of the particular refiners. There are substantial variations in design specifications, operating conditions, degree of integration with other units, and desired product quality. This analysis, therefore, gives a realistic appraisal of Unifining costs over a broad span of commercial practice. It is not intended as a comparison of the performance of different plants, nor as an index of the costs for treating a particular stock.

The data presented for the four plants were obtained from the refiners who operate these units. The costs are representative of their most recent full year of operation. For each plant, there is presented a brief summary of process performance together with a tabulation of direct costs for (1) operating labor and supplies, (2) maintenance, (3) utilities, and (4) catalyst.

In Item 1 are included wages plus social benefit allowances for unit operators, and the cost of normal operating supplies. Item 2 includes labor and materials for both onstream and turnaround maintenance. Utility costs given in Item 3 include fuel, electric power, steam and water. It should be noted that utility costs, and all cost data presented here, are as charged by the individual refiners. The costs of fuel and steam in particular varied widely, with the former ranging from less than 5 cents to 30 cents per million Btu, and the latter ranging from 25 cents to 55 cents per thousand pounds.

Catalyst costs are computed from barrels of feed processed and cost to the refiners of total catalyst used, including make-up where necessary. In three of the four units, the original catalyst is still in service. However, all catalyst costs were based on life to date, with no credit for life still available. The catalyst in service in all of the units was developed by Union Oil Company of California and is manufactured by Harshaw Chemical Company.

Supervision, overhead, insurance and taxes, often described as direct operating costs, have not been included here. These items vary widely in definition and accounting practice, and were not readily available from the contributing refiners. Hydrogen costs were excluded for similar reasons. In all cases cited the hydrogen is surplus from a catalytic reformer. Some refiners classify the surplus hydrogen as waste gas at no value; others assess fuel gas value; and still others, in the case of combination Unifining-reforming units, account for only the net hydrogen make from both units.

COST EXPERIENCE

The data in Table 3 are from a 16,000 bbl per day Unifining unit designed to produce feedstock for a platinum catalyst reformer. In addition to the reformer feed, a light stove oil cut is produced for use in the blending of premium stove oils, low pour point diesel fuels, and jet fuels. The charge stock is principally high-sulfur coker naphtha with some straight-run naphtha. The critical conversion is the elimination of nitrogen from the reformer charge fraction of the product. As the data show, nitrogen is reduced to substantially nil, and better than 99 percent sulfur removal is achieved. After more than three years of operation, the original catalyst charge is still in the unit; it has been regenerated ten times. The catalyst activity after the last regeneration was completely satisfactory for continued service.

The total direct costs for operating labor and supplies, maintenance, utilities, and catalyst have averaged 7.2 cents per barrel of feed processed. Of this total, only 0.9 cent per barrel of feed has been the cost of catalyst. Inasmuch as the initial catalyst charge is still in use, this cost is expected to drop considerably before the catalyst is replaced.

Table 4 shows typical feed and product characteristics and direct operating costs for a 900 barrel-per-day Unifining unit. This unit processes, in

TABLE 3—Unifining Reformer Feed and Stove Oil

	16,000 Bbl. Per Day Unit Mixed Coker and Straight-Run Feed		
		Products	
	Charge	Reformer Feed	Stove Oil
Gravity, deg API	46.9	52.7	37.0
Boiling Range, deg F	220–430	160–400	410–490
Sulfur, weight percent	1.37	0.006	0.026
Nitrogen, parts per million	151	<0.1	<0.1
Bromine Number	45	0.7	1.0
Direct operating costs, cents per barrel:			
Operating Labor and Supplies		1.1	
Maintenance		1.6	
Utilities		3.6	
Catalyst[a]		0.9	
Total		7.2	

a. Original catalyst still in service. Cost based on life to date.

TABLE 4—Unifining Stove Oil and Diesel

	900 BPD Unit Straight-Run Feed Blocked Operation			
	Stove Oil		Diesel	
	Charge	Product	Charge	Product
Gravity, deg API	42.8	43.0	35.4	36.1
Boiling Range, deg F	350–520	....	380–675	....
Sulfur, weight percent	0.16	0.02	0.66	0.25
Direct Operating Costs, cents per barrel:				
Operating Labor and supplies		1.1		
Maintenance		1.8		
Utilities		0.8		
Catalyst[a]		0.8		
Total		4.5		

a. Original catalyst still in service. Cost based on life to date.

TABLE 5—Unifining Wide-Range Distillate

	Charge	5,000 BPD Unit Straight-Run Feed		
		Products		
		Light Straight-Run	Reformer Feed	Premium Mid-Barrel
Gravity, deg API	47.5	77.5	55.0	36.8
Boiling Range, deg F	105–625	0–260	200–390	360–625
Sulfur, weight percent	0.53	0.01	0.015	0.06
Direct Operating Costs, cents per barrel:				
Operating labor and supplies	1.1			
Maintenance	1.2			
Utilities	3.4			
Catalyst[a]	0.8			
Total	6.5			

a. Original catalyst still in service. Cost based on life to date.

TABLE 6—Unifining No. 2 Heating Oil

	12,000 BPD Unit Mixed Cracked and Straight-Run Feed	
	Charge	Product
Gravity, deg API	29.0	39.5
Boiling Range, deg F	350–670	—
Sulfur, weight percent	1.0	0.4
Bromine Number	22	7
Direct Operating Costs, cents per barrel.		
Operating labor and supplies	0.8	
Maintenance	2.8	
Utilities	4.1	
Catalyst	1.2	
Total	8.9	

blocked operation, both stove oil and diesel fuel to yield low-sulfur, mercaptan-sweet products. In order to minimize downtime during regeneration, two charges of catalyst are rotated in service. The catalyst has been in use for 3½ years. Each charge has been regenerated only twice, and after the last regeneration was essentially equal in activity to new catalyst.

The direct operating costs have totaled 4.5 cents per barrel of feed processed. Of this total, catalyst cost has been only 0.8 cent. Based on experience to date, this refiner predicts that his catalyst cost will drop well below 0.5 cent per barrel of feed before catalyst replacement becomes necessary.

Table 5 shows performance and direct operating cost data for a 5,000-bpd Unifining unit operating on a wide-range distillate. This unit simultaneously produces three low-sulfur products, light straight-run, reformer feed, and premium midbarrel. The feed contains 0.53 weight percent sulfur. The plant has been onstream for approximately 2 years. The initial catalyst charge has been regenerated only twice and shows no significant activity decline.

Direct operating costs for this unit have totaled 6.5 cents per barrel of feed. Of this, 5.7 cents has been for operating labor and supplies, maintenance, and utilities. Catalyst cost to date has been only 0.8 cent per barrel of feed. Again, this cost is expected to fall much lower before catalyst replacement becomes necessary.

Performance and operating cost data for a fourth Unifining unit are presented in Table 6. This 12,000-bpd unit has been in service for more than three years on desulfurization of mixed cracked and straight-run gas oils. The product is No. 2 heating oil. The data show typical operation and average costs over the total service period of a single charge of catalyst. This catalyst charge was regenerated 15 times. The direct operating costs for this operation averaged 8.9 cents per barrel of charge stock, of which 1.2 cents was for catalyst.

Original presentation before the American Petroleum Institute, Division of Refining, Los Angeles, May 14, 1958.

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About the Authors

W. J. Baral is a process engineering supervisor at Union Oil Co. of Calif.'s Research Center, Brea, Calif. He supervises commercialization and evaluation of new and improved petroleum processes. Baral received a B.Ch.E. degree from the University of Minnesota in 1941, and joined Union Oil as a research and development engineer that same year. He went with C. F. Braun & Co. in 1951 as a process engineer, returning to Union Oil as a process engineer in 1952, and later reaching his present position.

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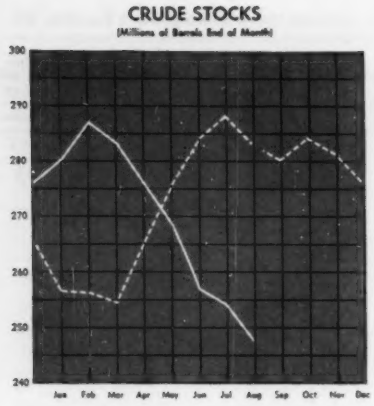
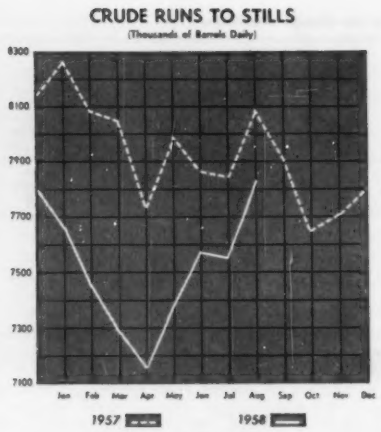
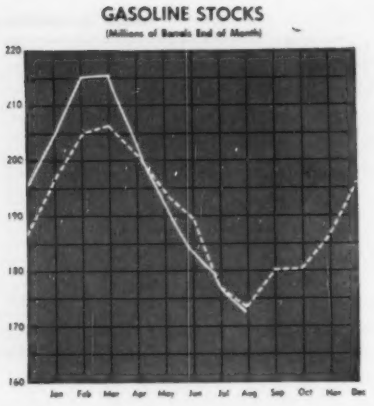
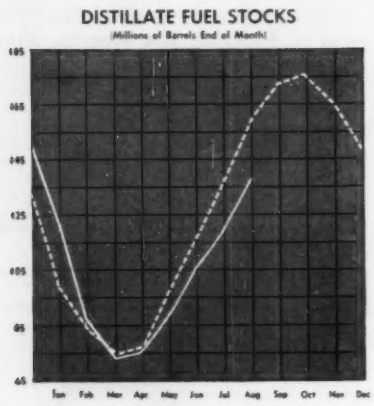
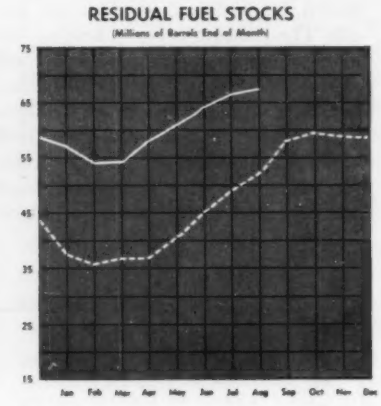
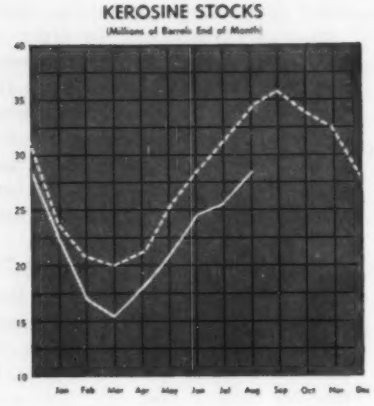












Taking Stock

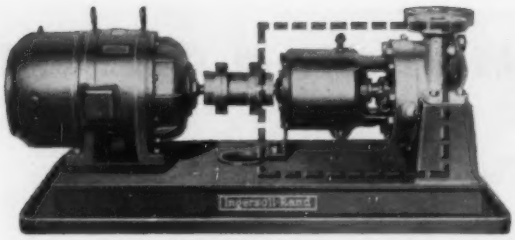
- Crude stocks continue to drop
- Crude runs hit yearly high
- All other stocks following seasonal trends

U. S. Monthly Oil Trends
(THOUSANDS OF BARRELS DAILY)

	AUGUST			July	JANUARY–AUGUST		
	1958	1957	%Diff.	1958	1958	1957	%Diff.
U.S. Crude Oil Production	6,873	6,789	+ 1.2	6,504	6,521	7,324	—11.0
U.S. Nat. Gas Liquids Prod	790	786	+ 0.5	780	781	803	— 2.7
U.S. Total Imports	1,567	1,695	— 7.6	1,597	1,621	1,541	+ 5.2
East Coast Crude Imports	723	961	—24.8	685	755	743	+ 1.6
Total Crude Imports	923	1,257	—26.6	852	926	996	— 7.0
Total Refined Products	644	438	+47.0	745	695	545	+27.5
Total New Supply	9,230	9,267	— 0.4	8,826	8,916	9,669	— 7.8
Stock Changes All Oils (Daily)	+490	+539	.....	— 99	—224	+229	.....
Total Demand All U.S. Oils	8,740	8,728	+ 0.1	8,925	9,140	9,440	— 3.2
Gasoline Demand	4,158	4,262	— 2.5	4,275	3,924	3,979	— 1.4
Distillate Fuel Demand	1,121	1,175	— 4.6	1,210	1,744	1,785	— 2.3
Residual Fuel Demand	1,310	1,367	— 4.2	1,300	1,439	1,626	—11.5
Domestic Demand, All Oils	8,490	8,324	+ 2.0	8,675	8,879	8,768	+ 1.3
Export Demand, All Oils	250	404	—38.1	250	261	672	—61.2
Crude Runs U.S. Refineries	7,803	8,092	— 3.6	7,564	7,507	7,994	— 6.1
Domestic Crude Runs	6,783	6,852	— 1.0	6,658	6,573	7,018	— 6.4
Foreign Crude Runs	1,020	1,239	—17.7	906	934	976	— 4.3

	TOTAL U.S. STOCKS Millions of Barrels End of Month				STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month			
	AUGUST			July	AUGUST			July
	1958	1957	%Diff.	1958	1958	1957	%Diff.	1958
Crude Oil	247.1	283.4	—12.8	249.9	205.5	247.0	—16.8	207.5
Gasoline	173.8	174.0	— 0.1	178.7	150.5	148.7	+ 1.2	153.6
Distillate Fuel Oil	139.6	159.1	—12.3	120.4	125.4	142.7	—12.1	107.1
Residual Fuel Oil	67.5	52.6	+28.3	66.9	34.1	33.2	+ 2.7	34.3
Kerosine	28.7	34.6	—17.1	28.7	28.4	34.2	—17.0	25.5

Source: Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report; except U.S. Natural Gas Liquids Production and Demand figures which are estimated by World Oil.

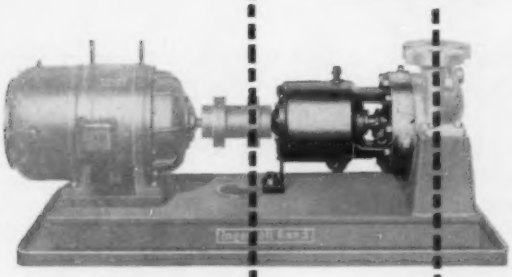


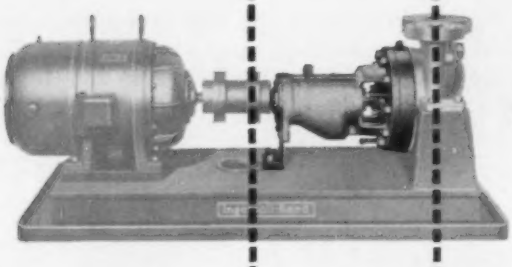
This "multi-process" pump

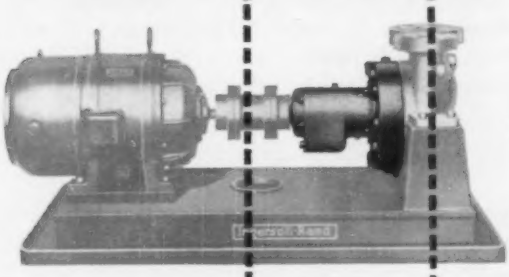
now handles

a wider range of applications

with unequalled interchangeability of parts







Here's how Ingersoll-Rand "tailors" its SFL line of heavy-duty pumps to meet your process requirements at least cost:

SFL . . . high-temperature service up to 800°F.
This is the basic water-cooled heavy-duty pump which has gained industry-wide acceptance for ruggedness and long-term dependability. It is designed specifically for hot-liquid services and is available with packed box or mechanical seals.

SFLM . . . medium temperature up to 300°F.
Take away the water-jacketing from the SFL and you have the SFLM . . . the same rugged pump *at a lower first cost*, designed for medium-temperature service. Should you later decide to put this pump on high-temperature service, *you can easily convert it to water-cooled operation.* Simply change to a water-cooled stuffing box extension and bearing housing. Available with packed box or mechanical seal.

SFLA . . . up to 200°F . . . with built-in mechanical shaft seal as standard equipment.
The seal eliminates packing maintenance and permits complete enclosure of the seal box . . . a definite safety factor. Within its rating, the SFLA is the most economical selection with single mechanical seal.

3 designs for one basic pump...
all available with top or end suction for heads to 750 ft, capacities to 900 gpm

WITH Ingersoll-Rand's newly extended line of "multi-process" pumps, you can now select from three basic types . . . and get exactly the pump you want for each specific application. You get maximum interchangeability of parts, plus the first-cost economy which results from a basically *standard* production model.

Whether your process can be best served by one of these "multi-process" pumps or by other models manufactured by Ingersoll-Rand, you can be sure that your I-R pump specialist will give you objective, expert counsel. Ingersoll-Rand makes *the most complete line of centrifugal pumps* available for the process industries.

Ingersoll-Rand

10-860 **11 Broadway, New York 4, N. Y.**

THERE'S NO SUBSTITUTE FOR EXPERIENCE IN ENGINEERED PRODUCTS

Valuable Reading Ahead

Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.

My! Times Do Change

That's why you should read "Changing Times," a fast moving account of those items that made news in the industry last month. It is just what the doctor ordered for busy industry men who don't have time to wade through many paragraphs to get to the meat of the subject. And, right after "Changing Times" is REFINER's handy meetings calendar, now expanded to two columns so you will have word of important events in the industry months in advance. See for yourself!

Keep Going to Page 217

You Should Know

"What Suppliers Are Doing" is the department where you will find information you need to know about the companies and men that supply the oil, gas and petrochemical processing industry. This handy guide will help you keep up with the people who serve your plant, and any extension of facilities which will be of service to you.

Keep Going to Page 230

Another Boxscore

Once again this month, PETROLEUM REFINER presents its quarterly compilation of refinery, natural gasoline, and petrochemical plant construction projects from all over the world. Keep pace with construction happenings by studying "Construction Boxscore," the most complete and up-to-date guide to building in the industry.

Keep Going to Page 169

Do It Yourself

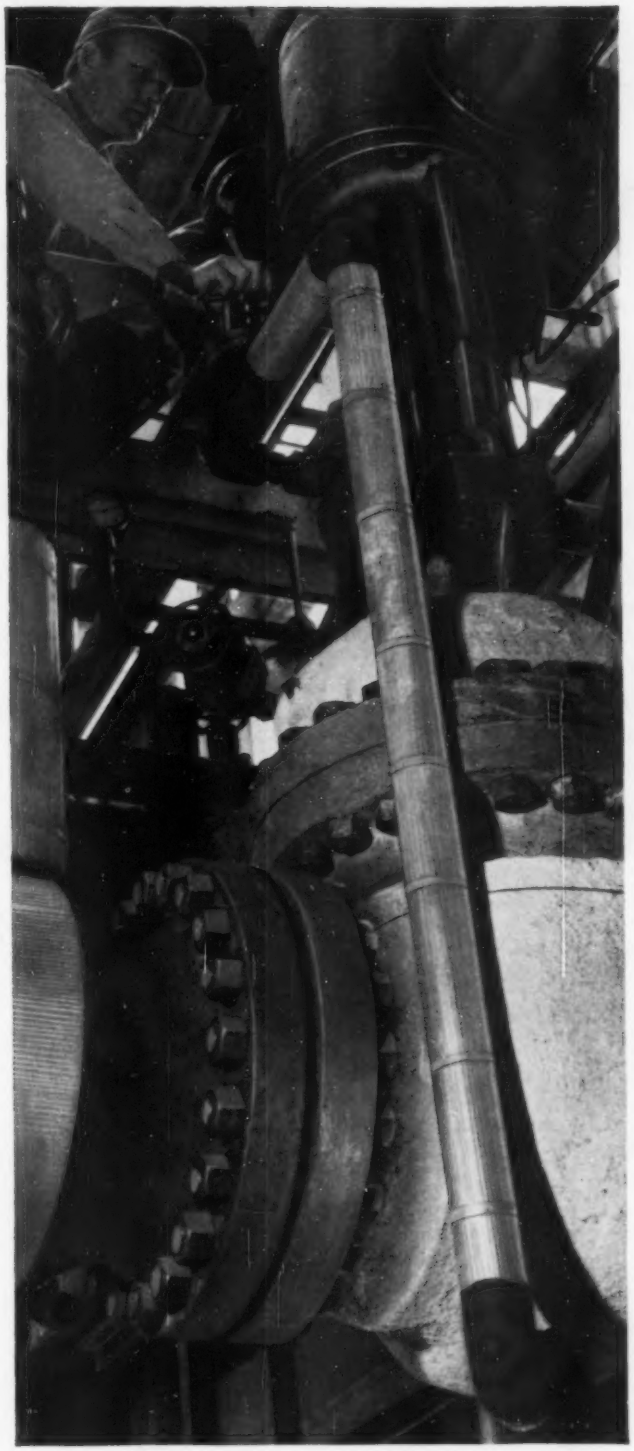
"How To Do It" is PETROLEUM REFINER's "do-it-yourself" section. Each month it describes several handy items designed to save you and/or your company money, time or both. Be sure to read these clever reader-contributed tips.

Keep Going to Page 140

A Refining Hall of Fame

Among the special features in PETROLEUM REFINER's special Oil Centennial Issue coming up in January, 1959, will be a Refining "Hall of Fame" honoring those 15 or 20 individuals who have contributed the most to the Oil, Gas and Petrochemical processing industry. We would like for each reader to submit the name of the one man he thinks has contributed the most to this industry. There are no special rules—if you think a man should be nominated, just let us know about it. All you have to do is write his name on the special postage-paid postcard just opposite page 260 of this issue. From these nominations, the final choice will be made for the Refining "Hall of Fame."

Keep Going to Page 260



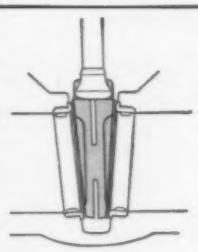
Safety-Minded Refiner Uses
CRANE Valves on Ultraformers

CRANE flexible disc gates hold hot hydrocarbon where other valves can't

The job of isolating the hot hydrocarbon from oxygen-containing regeneration gas in Ultraforming units is given to Crane 14-inch, 600-pound steel gate valves with a *flexible* disc. Once the valve is closed, inert gas is injected between seating faces to purge all traces of hot hydrocarbon. Crane motor-operated valves of the type pictured have performed successfully in Ultraforming units for more than four years.

Ordinary solid wedge gate or plug-type valves cannot provide the positive upstream seating demanded for this and similar refinery operating conditions. The Crane *flexible* wedge disc greatly minimizes the possibility of seat leakage caused by line strains or by uneven temperature or pressure conditions.

For complete details about Crane *flexible* wedge disc gate valves for process or power piping, see your Crane Representative or write to the address below.



Showing positive wedging principle of Crane flexible disc gate valve.... holds tight at both seat faces...upstream and downstream. Also overcomes sticking of disc when closed hot and opened cold.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING • KITCHENS

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .

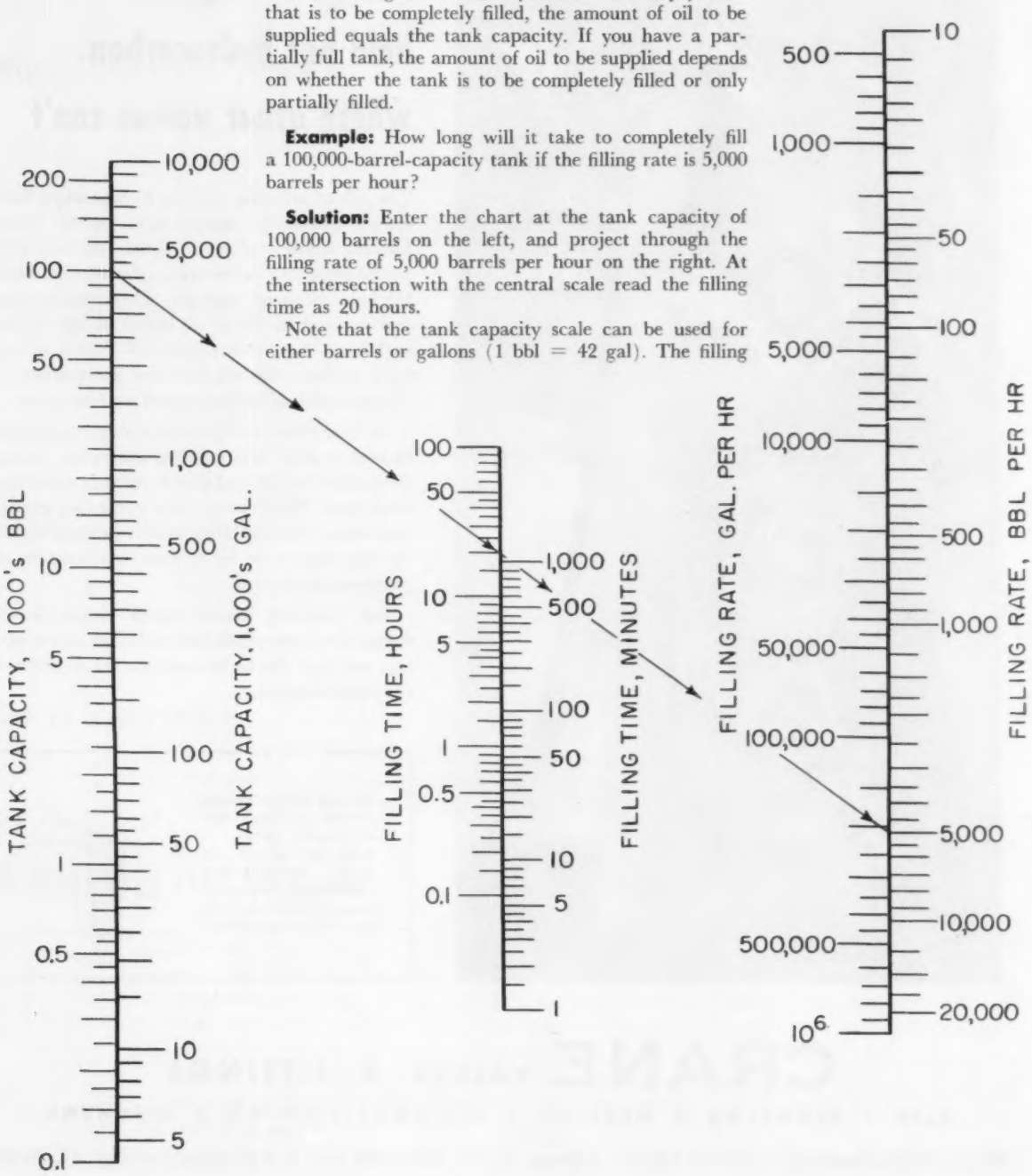
Chart Shows Time Needed to Fill Tank

The time required to completely or partially fill a tank depends on the amount of oil to be supplied to it, and the filling rate. When you have an empty tank that is to be completely filled, the amount of oil to be supplied equals the tank capacity. If you have a partially full tank, the amount of oil to be supplied depends on whether the tank is to be completely filled or only partially filled.

Example: How long will it take to completely fill a 100,000-barrel-capacity tank if the filling rate is 5,000 barrels per hour?

Solution: Enter the chart at the tank capacity of 100,000 barrels on the left, and project through the filling rate of 5,000 barrels per hour on the right. At the intersection with the central scale read the filling time as 20 hours.

Note that the tank capacity scale can be used for either barrels or gallons (1 bbl = 42 gal). The filling



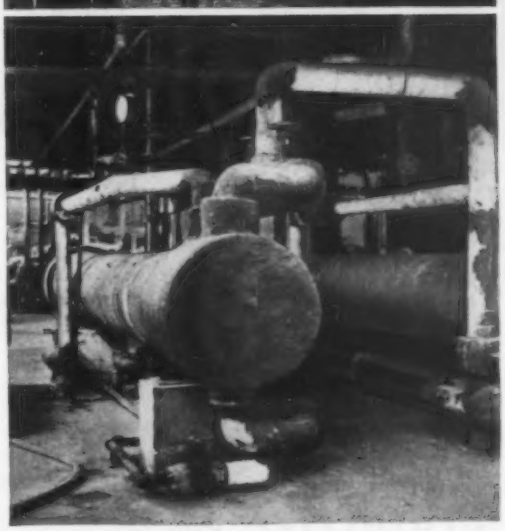
IN TOWERS . . .

Monel* nickel-copper alloy saves $20,000 a year in maintenance costs for a large southern refinery. Solid 7/16 inch Monel walls protect the stripping tower in the Unisol unit from the corrosive bite of 47° Baume caustic at 290° to 300°F.

Three spots where refineries using caustics save money with Monel alloy

IN BOTTOM CONES OF AGITATOR TANKS . . .

Monel alloy has proved to be the most economical material to use for this service. In this agitator tank, at an eastern refinery, wax is washed free of caustic with hot water. Bottom and walls are Monel alloy.



IN REGENERATOR PRE-HEATERS . . .

Monel is giving years of trouble-free service. The heat exchanger is exposed to contaminated caustic entering the regenerator tower and to pure caustic leaving it. Shells and tubes are Monel alloy.

Monel alloy is also being used for reboiler tube bundles, hot caustic lines and caustic storage vessels. In petrochemical uses of caustics, Monel alloy has done much to upgrade product purity.

Next time you need material to handle caustic, keep Monel alloy in mind. And keep Inco's Development and Research Engineers in mind, too. They'll be happy to give you the benefit of their wide field experience in solving caustic corrosion problems. *Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.

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NICKEL ALLOYS PERFORM BETTER LONGER

For more data on advertised products, use Readers' Service Cards, last page.

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PLASITE®

- For Refining Process immersion service
- For Oil Production equipment
- For Heavy Spills and Fumes
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- For Tankers and Tank Cars

PROVEN BY LONG FIELD HISTORY IN

High temperature de-ionized tank lining.
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Cooling towers, hot pipings, fans, and structural steel.
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Concrete tanks, floors, sumps, and bases.
PLASITE Cold Set formulated Coatings from combinations of High Resistant Resins are economical to use.

HEAVY SOLIDS with good coverage . . . HEAVY BUILD 5 to 15 mils per coat without sacrificing film quality . . . MINIMUM NUMBER OF COATS due to heavy build feature, saves labor . . . WIDE CHEMICAL RESISTANCE — all PLASITE formulations have excellent overall chemical and specific superior resistance . . . HIGH TEMPERATURE RESISTANCE from 350° to 400°F. on Dry Film basis . . .EXCELLENT BOND — Primers are not required on white blasted steel surface . . . AIR DRYING Field applications without baking or insulation.

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CAULKING COMPOUNDS
PRIMERS
BAKING COATINGS
HEAT RESISTANT COATINGS TO 1200°F.

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GREEN BAY, WIS.
REPRESENTED IN PRINCIPAL INDUSTRIAL AREAS

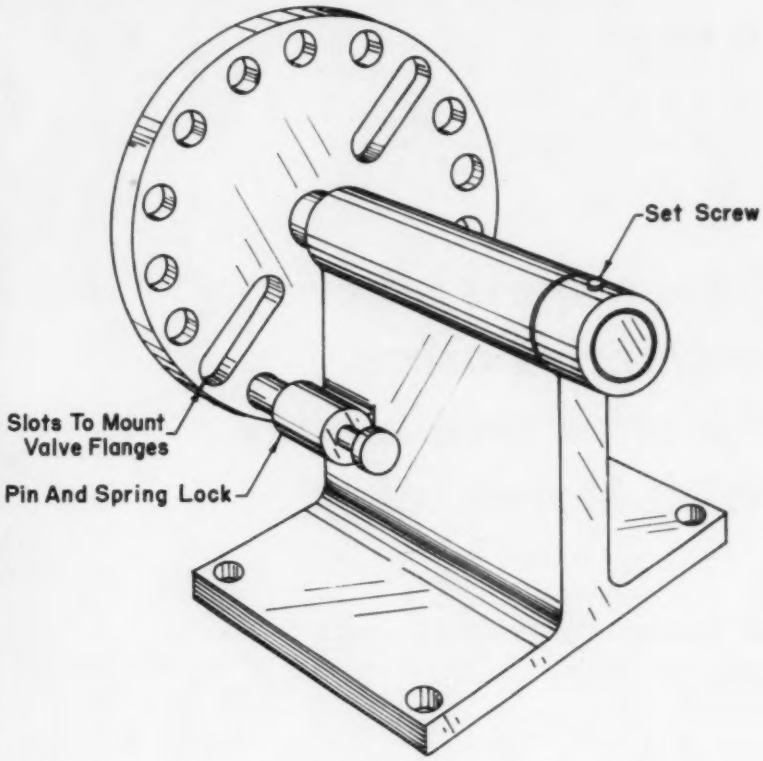
How to Do It . . .

rate scale can also be used in the same way. The filling time scale is divided in hours and minutes.

This chart is based on the relation

$$\text{Filling time} = \frac{\text{Tank capacity, bbl or gal}}{\text{Filling rate, bbl or gal per hr}}$$

This idea was submitted by Steven D. George, International Engineering Associates, New York.



Slots in Jig Make Valve Servicing Easy

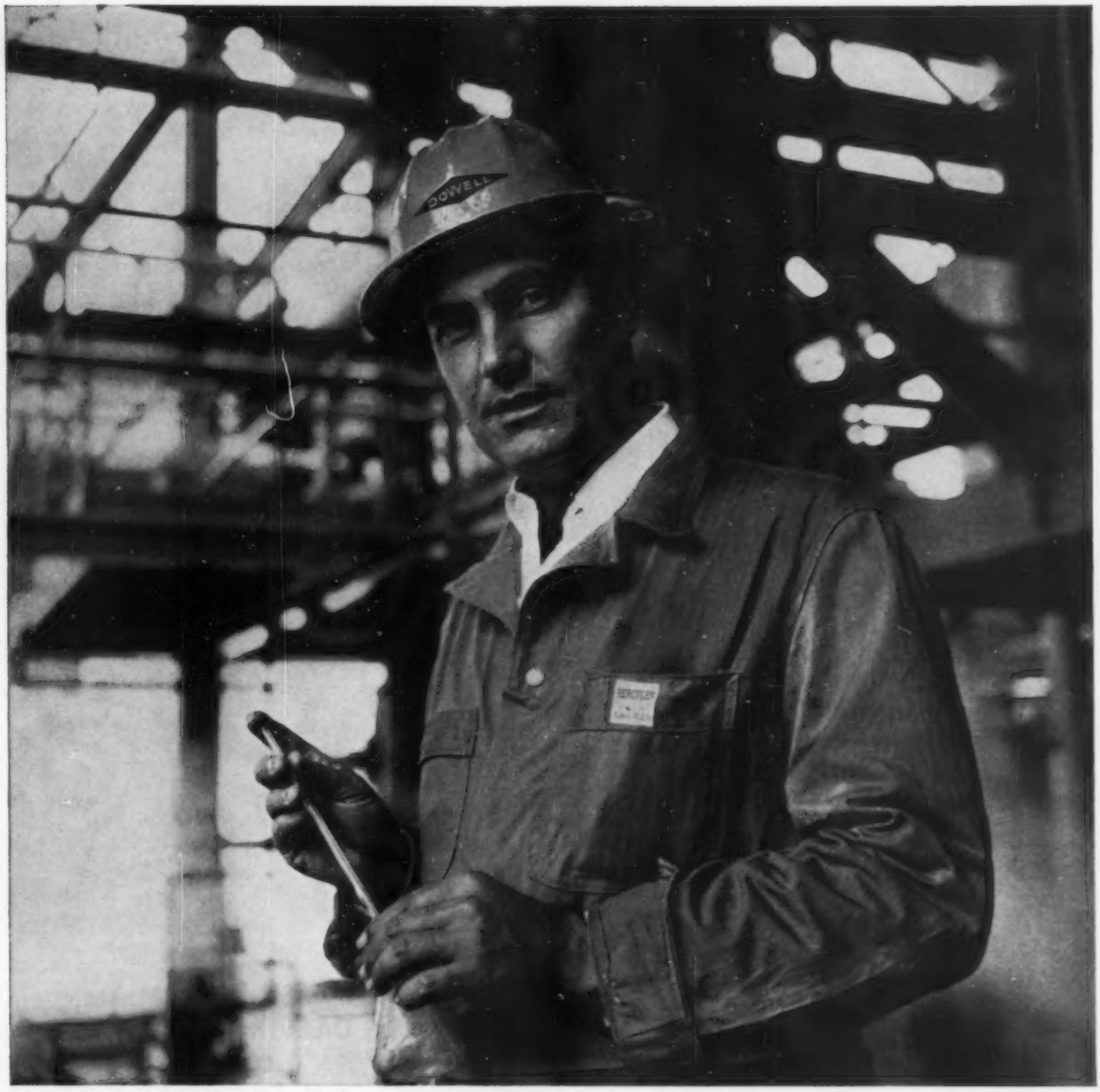
Valves are clumsy items to work with. When you set them on a work bench, they tip over very easily. Consequently, it usually takes one hand and your hip to hold a fairly large valve, while you work on it with the free hand.

A simple solution to this problem is to make the above pictured jig for holding flanged valves. The jig face can be made from one half inch steel plate, and of a diameter equal to the largest valve that you normally service in your shop. The valve flange bolt holes are lined up with the jig face slots and the two are connected with bolts and nuts. The assembly can be rotated 360 degrees, and is held in place by a pin and spring lock that snaps into one of the holes drilled in the jig face.

The jig should be bolted to the edge of a work table. Now, with both

$$ Your Ideas Are Valuable! $$

At least $10.00 will be paid for each idea accepted for "How To Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Petroleum Refiner, P. O. Box 2608, Houston.



HE CAN "MEASURE" MORE PROFIT FOR YOU. This Dowell service engineer can measure the amount of scale he removes from a line, using the Dowell method of chemical cleaning. *This removed scale and sludge can also be measured in increased profit dollars for your company.*

Example: Scale build-up in the main water supply line of a major Midwestern plant had reduced the "C" factor from 105 to 72. This situation became apparent just at the start of the peak season for the company. Management had a choice between laying an auxiliary line or trying to clean their present one. They decided to clean the line—but not the old-fashioned mechanical way. Time would not permit. Dowell was called in to do the job—chemically.

Dowell Service was fast—the job was done in three days. Dowell Service was effective—the "C" factor was increased to 92. Dowell Service was profitable for the customer—$71,000 was saved and the company's annual profit was protected.

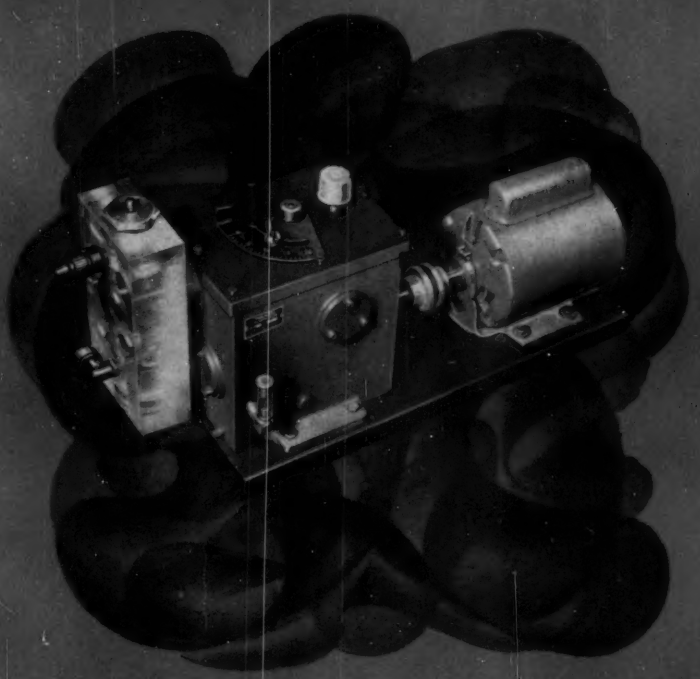
With Dowell Service you receive the benefits of more than fifteen years experience in chemical cleaning—plus a full line of equipment, chemicals, and trained personnel. You pay one charge, get an efficient job, handled by experienced people.

Your maintenance and operating engineers probably know about Dowell Service. Ask them for the facts. Decide for yourself about the additional profit possibilities to your company with Dowell Service working for you. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma, with 165 offices and stations to serve you.

Chemical cleaning service for industry DOWELL

MANZEL

gives you constant-mix slurry pumping



NO SLURRY SETTLING with Manzel's new SP-90 Slurry Pump! Exclusive feature permits proportion of slurries to remain constant in mix tank . . . while pumping rates are variable from maximum to 1/5 of maximum. Your Manzel field engineer will give you full details.

FREE CATALOG: Write for complete catalog on Manzel Slurry Pumps and Chemical Feeders, giving details of construction, performance, applications.

Manzel

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Specialists in metering pumps and lubricators since 1898

How to Do It . . .

hands free, watch your valve maintenance costs drop.

This item was submitted by Jack O. Evans of E. I. du Pont de Nemours & Co., Inc., Victoria, Texas.

Bob Sled Rack Makes Drum Handling Easy

A drum rack with a rocking chair corner will make it easy to empty the drum's contents. The rack corner is placed under the edge of the drum, and the drum is easily flopped onto the rack. When the contents are nearly emptied, the drum is reversed on the rack and propped up so the last bit can be drained out.

As shown, the rack is made from ¾-inch rods and welded together to make a tall bob sled effect. A plate is welded across the end which can easily be slipped under the edge of the drum bottom. When pressure is applied to the top, it is fairly easy to roll it over and allow it to lay on the side for emptying.

Casters mounted in the crook of the runners make it easy to move the drum around the warehouse.

More REACTIVE

SOLVAY CAUSTIC POTASH

...produces MORE SOLUBLE END PRODUCTS!

Many users select caustic potash, rather than lower cost caustic soda, because it saponifies fats and grease more readily, and—most important—provides extra efficiency.

Since it is more reactive, the products made from it are also generally more reactive—more soluble, more effective. In fact, many powerful cleaners—including some of the popular heavy-duty liquid detergents—are based on products produced from caustic potash.

We invite you to make your own test of SOLVAY Caustic Potash. Available in two grades —Technical and Mercury Cell—dry forms and liquid, in steel drums and tank cars.

Sodium Nitrite • Potassium Carbonate • Caustic Soda • Chlorine
Calcium Chloride • Sodium Bicarbonate • Ammonium Choride
Caustic Potash • Chloroform • Vinyl Chloride • Methylene Chloride
Para-dichlorobenzene • Methyl Chloride • Cleaning Compounds
Hydrogen Peroxide • Aluminum Chloride • Ammonium Bicarbonate
Soda Ash • Carbon Tetrachloride • Mutual Chromium Chemicals
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SOLVAY dealers and branch offices are located in major centers from coast to coast.

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Please send me without cost:

Samples of Technical Grade Caustic Potash
☐ Flake ☐ Small Flake ☐ Solid
☐ Walnut ☐ Liquid, 45% strength
☐ Liquid, 49-50% strength

Samples of Mercury Cell Caustic Potash
☐ Flake ☐ Liquid

☐ Caustic Potash fact book

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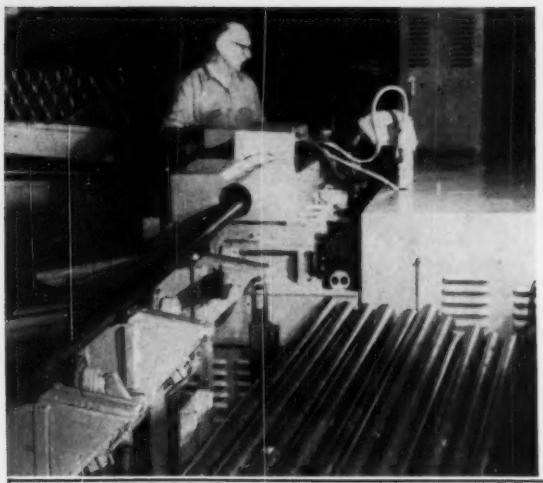
For more data on advertised products, use Readers' Service Cards, last page.

QUALITY YOU CAN MEASURE

Republic ELECTRUNITE Heat Exchanger Tubing



Quality is controlled! Republic ELECTRUNITE® Heat Exchanger Tubing is produced by one integrated, responsible producer—Republic—who controls quality from mine, through mill, to finished product.

Quality is built-in! ELECTRUNITE is formed from highest quality flat-rolled open-hearth steel and "electrically-welded" by the exclusive ELECTRUNITE process that unites the tube under pressure without the addition of foreign or extra metal.

Quality you can see! ELECTRUNITE is uniform in wall thickness, diameter, concentricity, strength, weight, surface finish. All reasons why ELECTRUNITE Heat Exchanger Tubes slide in easily, expand evenly, roll-in and bead over quickly, meet critical performance specifications.

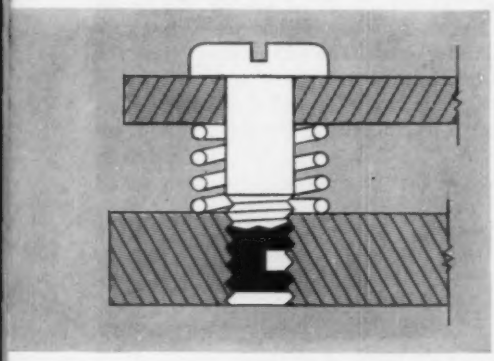
To learn more about the cost saving performance advantages of ELECTRUNITE, call your Republic representative, or write direct.

Wall Thickness	Minor Dimension of the Defect (Length or Depth)	Length X Depth Area in Square Inches
20 ga.	.006"	.0025"
18 ga.	.006"	.003"
16 ga.	12½% of Wall	.003"
14 and 13 ga.	12½% of Wall	.004"
12 ga. and heavier	12½% of Wall	.005"

FARROWTEST detects and rejects defects completely penetrating tube wall, or equal to, or greater than, those shown in this table. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

QUALITY YOU CAN MEASURE — FARROWTEST® Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects defects of critical size. The additional quality protection of exclusive FARROWTEST is offered as an alternative to other less positive tests . . . at no extra cost.

GUARD YOUR PRODUCTS AND PROFITS WITH REPUBLIC STEEL CONTAINERS. Republic produces a complete line of lightweight shipping drums in a wide range of sizes to meet applicable universal and ICC standards. They can be furnished with special high bake linings as required. Exterior finishes can be plain, painted, or fully decorated. For complete Republic Steel Container information, contact your nearest Republic office or write for free catalog.



REPUBLIC SELF-LOCKING NYLOK® BOLTS provide single-unit answer to vibration, liquid sealing, and adjustment problems. Secure grip is provided by nylon pallet permanently imbedded in fastener body. Continual pressure of resilient nylon forces tight metal-to-metal lock between mating thread. Write for additional data.

REPUBLIC ELECTRUNITE® "Dekoron®-Coated" Galvite Conduit outlasts standard conduit ten to one in highly corrosive conditions of service. It resists acid fumes, moisture and corrosion that attack standard heavy-wall conduit in the petrochemical field. A tough coating of polyethylene encases Hot Dipped Galvite Conduit in an end-to-end armor that resists moisture and corrosive fumes. Send coupon for data.

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World's Widest Range of Standard Steels and Steel Products

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☐ Republic Containers ☐ NYLOK Nuts and Bolts
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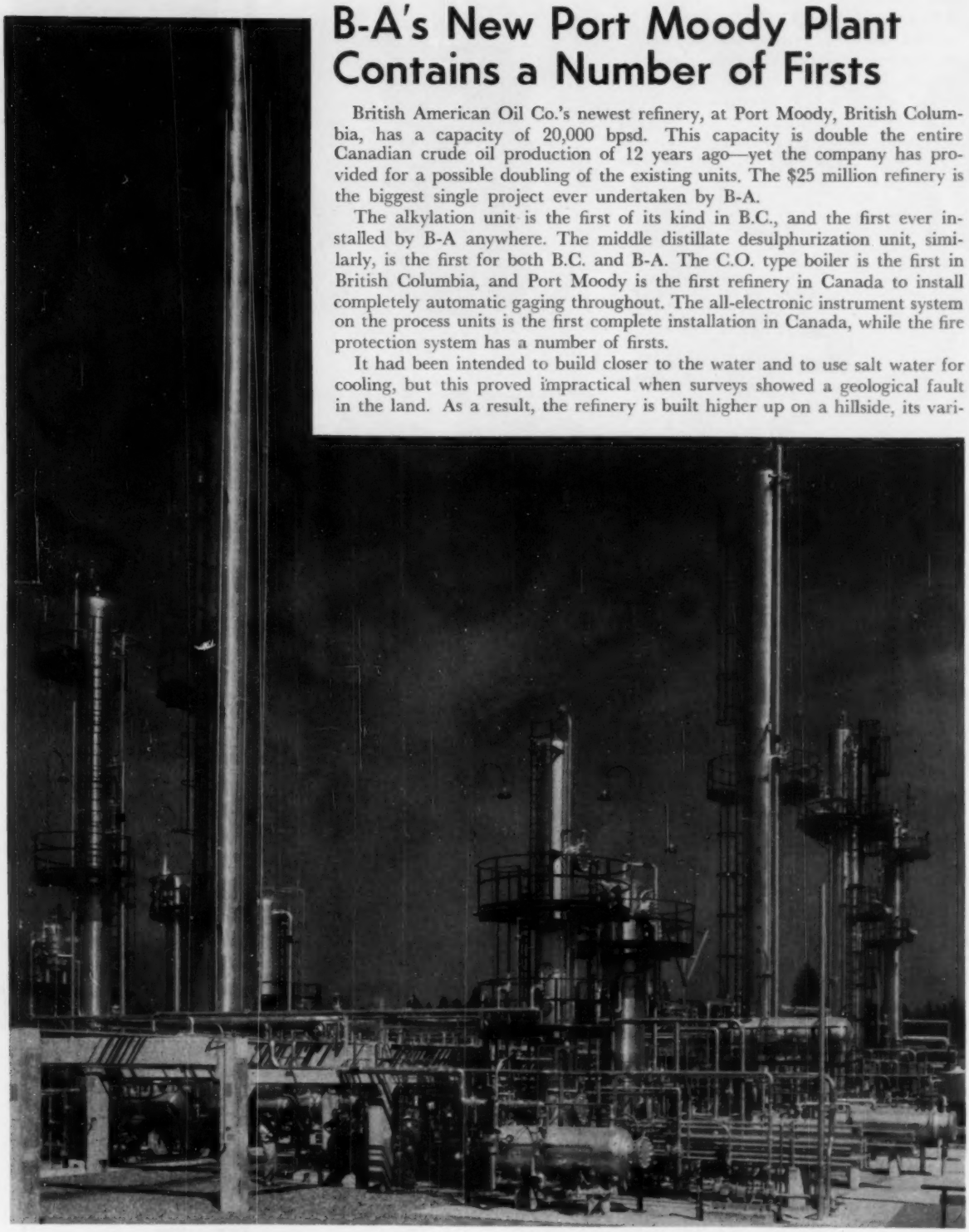
Who's Building . . .

B-A's New Port Moody Plant Contains a Number of Firsts

British American Oil Co.'s newest refinery, at Port Moody, British Columbia, has a capacity of 20,000 bpsd. This capacity is double the entire Canadian crude oil production of 12 years ago—yet the company has provided for a possible doubling of the existing units. The $25 million refinery is the biggest single project ever undertaken by B-A.

The alkylation unit is the first of its kind in B.C., and the first ever installed by B-A anywhere. The middle distillate desulphurization unit, similarly, is the first for both B.C. and B-A. The C.O. type boiler is the first in British Columbia, and Port Moody is the first refinery in Canada to install completely automatic gaging throughout. The all-electronic instrument system on the process units is the first complete installation in Canada, while the fire protection system has a number of firsts.

It had been intended to build closer to the water and to use salt water for cooling, but this proved impractical when surveys showed a geological fault in the land. As a result, the refinery is built higher up on a hillside, its vari-



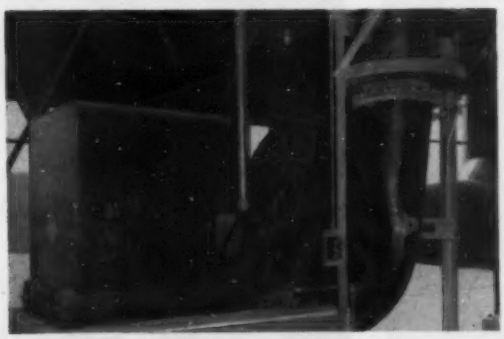
New 20,000-bpsd alkylation unit at Port Moody is a first for British American Oil and British Columbia.

ELLIOTT Centrifugal Compressors . . .

for flexibility in design
to meet your specific needs!

MULTISTAGE, TURBINE-DRIVEN . . .

this Elliott centrifugal compressor, rated 135,500 inlet cfm, inlet pressure 14.5 psia, discharge pressure 22.0 psig, is driven by an Elliott turbine rated at 12,440 hp, at 2400 rpm.



SINGLE-STAGE, MOTOR-DRIVEN . . .

this Elliott centrifugal compressor, rated 25,650 inlet cfm, inlet pressure 13.7 psia, discharge 16.7 psia, is driven by an Elliott 500-hp totally-enclosed air-to-air cooled induction motor at 3560 rpm.

For nearly fifty years, Elliott has been building centrifugal compressors for all applications. The standardized conservative design of Elliott compressors results in dependable service and low maintenance.

Manufacturing both turbines and motors which drive the compressors, Elliott is able to match drives to specific compressor requirements both in physical design and in performance.

Call your nearby Elliott District Office for detailed information, or write Elliott Company, Compressor Department, Jeannette, Pa.

P7-4

ELLIOTT Company

For more data on advertised products, use Readers' Service Cards, last page.

ous buildings terraced at different levels. Water is drawn from City of Port Moody mains.

PROCESS PLANT

The processing plant, incorporating the latest process and design features, includes combination crude topping and vacuum; catalytic cracking; naphtha desulphurization and catalytic reforming; middle distillate desulphurization and alkylation units. Contract for these units was placed with Canadian Kellogg Co., Ltd.

CRUDE TOPPING

The crude topping and vacuum unit has been designed to process 20,000 bpsd of Western Canadian crudes. Products yielded from the combined unit include gas, a 380 E.P. gasoline, kerosine or stove oil, diesel oil, atmospheric and vacuum gas oils and residuals. The unit is designed to operate independently when adjacent units are shut down.

CAT CRACKER

The Orthoflow "B" catalytic cracking unit is the second of its type installed by B-A—the first having been at Clarkson in 1954. The regenerator is mounted over the reactor instead of vice versa, resulting in capital and operating savings. The unit is capable of converting 9,000 bpsd of gas oil blend received from the combination crude topping and vacuum unit.

NAPHTHA DESULFURIZATION

The naphtha desulfurization section has a capacity of 6,000 to 7,000 bpsd and uses a cobalt molybdenum catalyst. From this section, the product goes to the catalytic reforming section where, using a platinum catalyst, it is reformed into high octane, low sulfur gasoline blending components. The catalytic reforming section can operate independently on low sulfur fresh feed stocks from storage.

MIDDLE DISTILLATE DESULFURIZATION

The middle distillate desulfurization unit opeates on 4,000 bpsd, using middle distillates from the combination crude topping and vacuum unit and from the catalytic cracking unit. It removes the sulfur, oxygen and nitrogen compounds. A cobalt molybdate catalyst is used, resulting in removal of 75 percent of the sulfur content of the feed stock. This assures superior burning characteristics, color stability and resistance to sludging in heating oils, diesel fuels and stove oil.

ALKYLATION

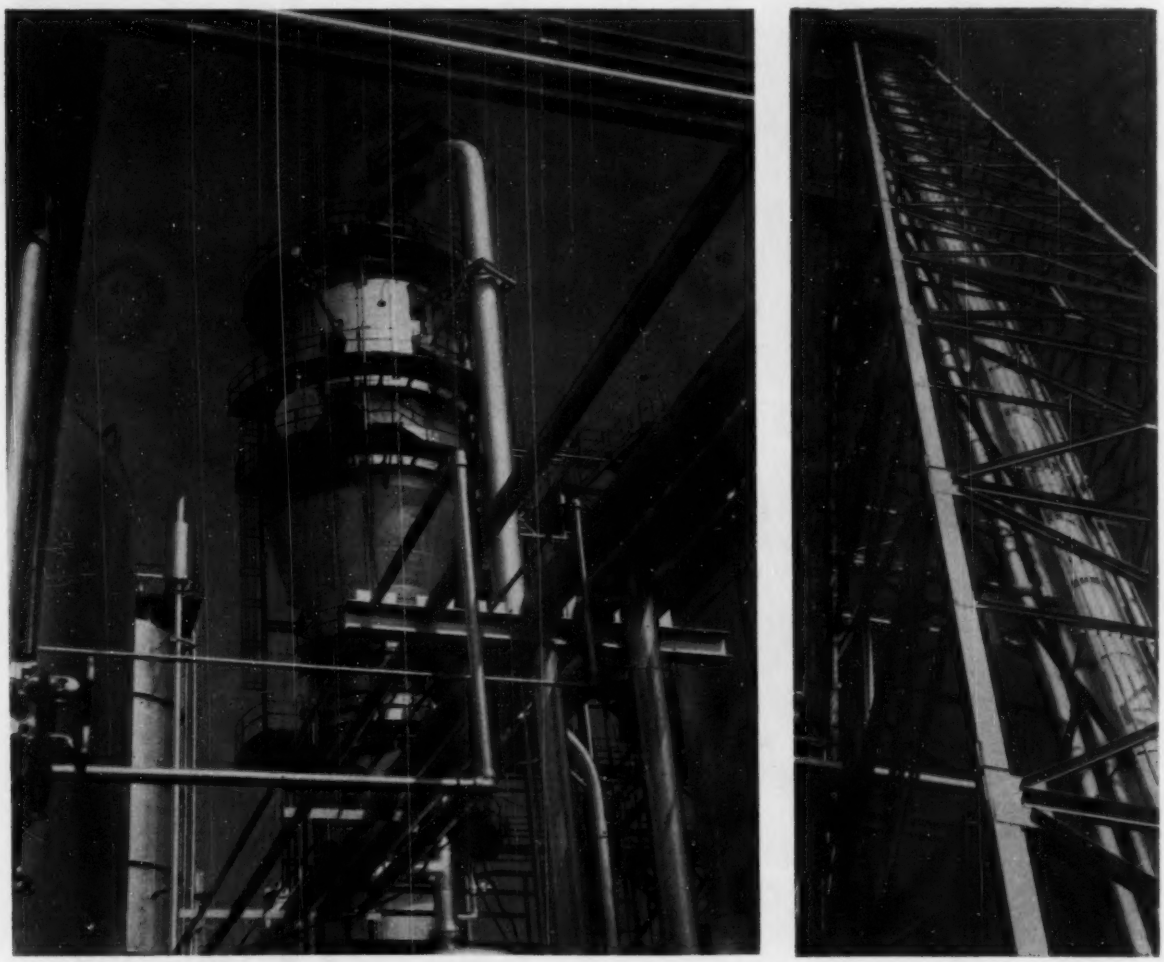
The alkylation unit is another first for B-A and B.C. Selected over other similar processes, it was chosen to ensure the high octane requirements of modern engines.

Feed stocks are obtained mainly from the catalytic cracking and catalytic reforming units and comprise liquid gases such as propylene, butylene and amylenes. With isobutanes added, they are processed with sulphuric acid to produce motor alkylate, having a research octane number of 105-108 with 3.6 cc's of TEL. The unit is designed to produce 1,050 bpsd of this blending component.

Prior to charging to the crude topping and vacuum unit, all crude oils are treated through a chemical desalting unit. Organic salts removal is approximately 95-100 percent complete.

Catalytically cracked gasoline is caustic treated through an electrical distillate treater to remove sulfur and phenolic compounds—thereby improving storage stability and clean-burning properties of the gasoline.

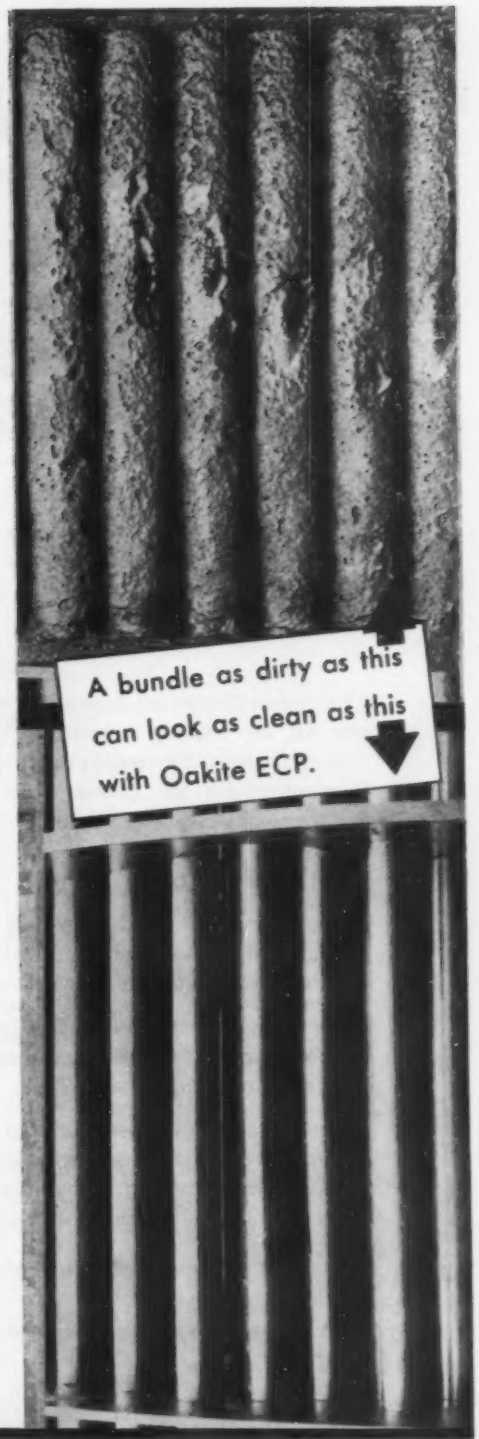
Thorough planning has been applied to waste disposal. The flare stack, of smokeless design, is 249 feet high and 42 inches in diameter, and complete sewage systems have been installed throughout the refinery area. These include storm, domestic, oily water and foul condensate sewers. The foul condensate is stripped of



For economy B-A's cat cracker has regenerator mounted over reactor (left). A 250-foot flare stack will burn waste gases (right).

Oakite ECP
engineered cleaning program

soak tank method cuts bundle cleaning costs 70%



Clogged almost solid with caked-on carbon, heat exchanger tube bundles took their toll on muscles and cleaning budget at one refinery. Hand sawing just one 60-tube, 12-foot bundle cost $392 in labor alone.

Refinery engineers called in the Oakite man. The ECP for this refinery included a recommendation to soak exchanger bundles in a hot solution of Oakite Compound No. 85. Now, there's no back-breaking manual labor needed. Bundles come out of the tank far cleaner than when handled manually, and the cost *per bundle* is only $120 including labor and Oakite material.

WHAT IS OAKITE ECP? It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

In our 50th year.

Export Division Cable Address: Oakite

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Oakite ECP
your economy key

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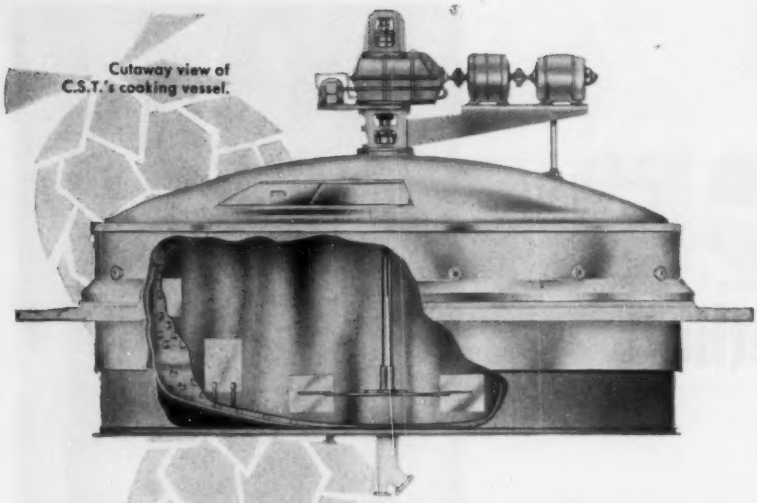


Cutaway view of C.S.T.'s cooking vessel.

What's New at C. S. T.?

C.S.T.'s new space saving "Dual Paraboloid" fermenting tank.

The vessels illustrated here are new for the brewing industry. They have helped increase production from a few barrels a day to many times that, yet the "Old World" brewmasters quality has been retained.

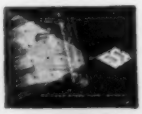
The same ingenuity and know-how that developed and fabricated these designs for this industry can be applied to your problem . . . whatever it may be.

In the petroleum and petro-chemical fields, C.S.T. has been turning out tanks and vessels—of all types, in all sizes and shapes—since 1899.

When you need equipment for your particular process, investigate the savings in time and money C.S.T. engineers can bring about for you. We're equipped to handle your complete requirements.

Our Most Important Products—QUALITY and SERVICE.

Write for your personal copy of the brochure describing C.S.T.'s facilities.



Custom fabricators and erectors since 1899

CHICAGO STEEL TANK COMPANY

division of U.S. INDUSTRIES, INC.

SALES OFFICES: 6400 W. 66TH STREET • CHICAGO 38, ILLINOIS • PO-7-8900
51 E. 42ND STREET • NEW YORK, N. Y. • MU-7-9298

Who's Building . . .

hydrogen sulfide and other contaminants.

Tankage facilities include 13 crude oil and gasoline tanks, capable of holding 617,000 barrels. All have been equipped with floating roof tanks.

Crude oil supplies will come from Western Canada, and initial transporation will be through the trans mountain pipe line from Edmonton to Burnaby. Some two miles of 12-inch branch pipe line has been constructed from the main tank farm at Burnaby to the refinery. Assisted by a 100 h.p. booster station, this branch line is capable of supplying the refinery with 80,000 bpd.

Particularly interesting is the completely electronic gaging system installed. Previous experience and past records have proved that the tedious task of gauging and reading temperatures of stored petroleum products by hand methods is no longer adequate. So, Port Moody has installed remote control automatic gaging facilities which will permit dialing a tank number for the correct quantity and temperature of the product stored. This automatic gaging equipment is the first of its kind ever installed in Canada to cover a complete refinery.

Sonap de Mozambique is planning a 10,000-bpd refinery to be located at Matola, near Lourenco Marques in Mozambique, East Africa. The plan, by Portuguese interests, was said to have gained the approval of the Lisbon government. The refinery was to be completed by 1960 with equipment purchased in Italy. Initial capacity was to be 4,000 bpd, and increased later to 10,000.

The Burmah Oil Co. (P.T.) Ltd., and three other companies, are planning a refinery for West Pkistan, at the Keamari Groyne in Karachi. The project report envisages a refinery costing about $33 million, designed to process approximately 1½-million tons of crude oil per year. A refinery of this size would be able to meet West Pakistan's presently estimated requirements of main petroleum products in 1962, excluding aviation gasoline.

Petroleos Mexicanos is building units to increase capacity of its Minatitlan, Mexico, refinery from 23,990 to 50,000 bpd. Upon completion, the refinery will produce liquid gas, supermexolina, mexoline, kerosine, diesel oils, lubricants, and combustion oils. All of these products have previously been imported by western Mexico.

The project includes a TCC unit to convert heavy gasoline into high octane gasoline.

Richfield Oil Corp. has completed a 3,500-bpsd Udex unit at its Wilmington, Calif., refinery. The process unit was licensed, designed and engineered by Universal Oil Products Co. It is separating 1,465 bpsd of high-purity benzene for chemical manufacture and 126 bpsd of nitration-grade toluene.

The unit is processing a depentanized feed stock derived from catalytically-reformed California naphtha.

British American Oil Co. will go on stream this month with its new natural gas processing plant near Pincher Creek, Southern Alberta. It is located on one of the largest wet gas fields ever discovered in Canada, and one of the major fields of

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MAJOR SOURCE OF MAJOR ACIDS

SULFURIC ACID

Commercial Grades of 77.67 to 122.5% H_2SO_4. *"Special Grade"* concentrations of 93 to 100% H_2SO_4 with iron guaranteed less than 50 ppm and similarly low content of nitrogen, arsenic and other impurities. *Electrolyte Quality* at Sp.Gr. 1.300, 1.360, 1.400, 1.500 and 1.835. *Oleum* in all concentrations from 15% free SO_3 to 100% Liquid SO_3 (equivalent to 103.38 to 122.5% H_2SO_4). *Regenerated* Acid sludges are decomposed, regenerated and delivered as water-white 98% H_2SO_4 on an established contract basis. *Spent Acids* from the manufacture of white oils, fuels, chlorine gas, alcohols, DDT, butadiene and other products are recovered, regenerated or fortified for re-use at the source or for different use. In any case, Stauffer processing and contract arrangements eliminate waste, eliminate air and stream pollution or the alternative of in-plant conversion of process residues.

MURIATIC ACID

Delivered in standard strengths of 18°, 20° and 22° Bé corresponding to 27.92, 31.45 and 35.21% HCl. Stauffer also offers an extremely high-purity, high-analysis grade of muriatic acid for special uses. All grades are available in tank cars, tank trucks and carboys.

NITRIC ACID

Commercial Grades of 38°, 40° and 42° Bé corresponding to 56.52, 61.38 and 67.18% HNO_3. *Engravers' Quality* of the same concentrations is conditioned to prevent fuming and discoloration of etching plates.

HYDROFLUORIC ACID

Anhydrous, is shipped in 22-ton and 42-ton tank cars, and in 100- and 200-pound cylinders from the Nyotex Chemicals Division of Stauffer Chemical Company at Houston; aqueous acid from the Stauffer plant at Louisville, Ky.

80 YEARS OF SERVICE TO INDUSTRY
testify to Stauffer Chemical Company's reliability as a major source of volume acids and an authoritative source of information on their use and handling.

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York
636 California Street, San Francisco 8, California
Consolidated Chemical Division: 6910 Fannin Street, Houston, Texas

Stauffer's Sulfuric Acid is shipped from Mobile, Ala., Los Angeles and Richmond, Cal., Hammond, Ind., Baton Rouge, La., Baytown, Fort Worth and Houston, Tex., and various stock points. Hydrochloric Acid is shipped from Richmond, Cal., and Fort Worth; Hydrofluoric Acid (anhydrous) from Houston; (aqueous) from Louisville.

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DO YOU HAVE THIS NEW BOOKLET?

DO YOU HAVE THIS NEW BOOKLET?

Write or phone to the address below for your file copy.

Here is an up-to-date description of National-U.S. facilities for designing and manufacturing shell and tube heat exchangers, and a summary of the most called-for types currently being built. It may suggest to you a number of different approaches to problems of heat transfer for petrochemicals and process reactions.

58-02

Heat Transfer Division
National-U.S. Radiator
CORPORATION
342 Madison Avenue • New York 17, New York

Who's Building...

its type in the world. Completion of this plant, according to the company, will make British American the largest single supplier of natural gas to the Trans-Canada Pipe Line. The plant will have a daily initial production capacity of 25,000 gallons of propane, 40,000 gallons of butane and 450 long tons of sulphur.

A/S Esso-Raffineriet, Norge, a new company which will build a $30 million petroleum refinery in Norway, has been formed by Standard Oil Co. (N. J.). Construction of the installation, which Jersey Standard described as the first major refinery in Norway, will begin this year. A location for the refinery has not yet been determined. Construction problems occasioned by soil conditions in Norway have caused broad studies of many sites, and several locations on the Oslo Fjord are being evaluated.

The projected refinery has been designed to process 40,000 bpd of Middle East crude. Principal products will include gasoline, jet fuel, heating oil, diesel oil, heavy fuel oil and marine bunker fuel. If the location permits, a terminal will be designed so later expansion will accommodate the largest tankers.

At present the only other refinery in Norway is a lube oil and asphalt plant operated by A/S Esso Norske.

Air Reduction Sales Co., a division of Air Reduction Co., Inc., has begun construction of a new oxygen and nitrogen plant at Denver. Estimated cost of the facility, including related distribution equipment, will be about $600,000. The general contractor is Stearns-Roger Manufacturing Co., Denver, and the plant is scheduled to start operation by January, 1959.

Cooperative Farm Chemicals Association is planning new ammonia and urea plants to expand its nitrogen producing facilities. The project, to be located at Lawrence, Kan., will be constructed by Chemical Construction Corp., and is slated for completion in August, 1959.

The ammonia plant, with a rated capacity of 100 tons per day, will be based on natural gas. Two stages of monoethanolamine scrubbing and methanation will be used for gas purification. The synthesis loop will have a capacity of 200 tons per day to provide for future expansion. The plant will include facilities for storing 15,000 tons of anhydrous ammonia at atmospheric pressure.

The urea plant will produce 30 tons per day of urea for preparing urea-ammonium nitrate solutions.

Tidewater Oil Co.'s Avon refinery has a new water purification plant. Designed to treat 667 gallons of water a minute, the new plant, one of the largest on the West Coast, will operate automatically to remove mineral impurities. It will further purify the water supplied to it by an already-existing water clarifying and filtering plant on the grounds of the 114,000-bpd refinery.

Demineralized water for use during any period when the new water treatment plant is out of service for maintenance will be stored in a specially-lined tank. The inside of this 1 million gallon tank is coated with polyvinyl chloride to pro-

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A New Way to Tell the Story* of GASOLINE PROGRESS!

*** to your friends, your neighbors, your customers**

CUSTOMER: What's the best way to measure gasoline performance?

DEALER: The best and newest way to measure gasoline performance is in "ton-miles" per gallon.

CUSTOMER: What are "ton-miles" per gallon?

DEALER: That's the distance one gallon of gasoline will move one ton of automobile. It takes into account the varying weights of today's cars.

CUSTOMER: That sounds reasonable, but what does it prove?

DEALER: That with today's gasoline, you drive a real bargain! Measured by the "ton-mile," today's gasoline does 70% more work than gasoline did in 1930.

CUSTOMER: 70%? That's a terrific improvement in gasoline performance.

DEALER: Right! In 1930, the average car on the road gave 25 "ton-miles" per gallon. Today, the average is 43 "ton-miles."

CUSTOMER: But how about the cost of gasoline per gallon?

DEALER: You gain there, too! In 1930, you spent ⅔ of a cent for gasoline for each "ton-mile." Today, you spend only a little over ½ a cent for each "ton-mile" you drive.

DEALER: *You're getting 70% more work out of your gasoline, and you're saving 18% while you do it!*

CUSTOMER: Fill 'er up!

The "TON-MILE" Story is the story of gasoline progress. Tell this story every chance you get. It'll be good for *your* business!

American Petroleum Institute, Dept. G
50 W. 50th Street, New York 20, N. Y.

I would like to obtain more information about today's gasoline quality, prices and taxes. Please send me your FREE booklets.

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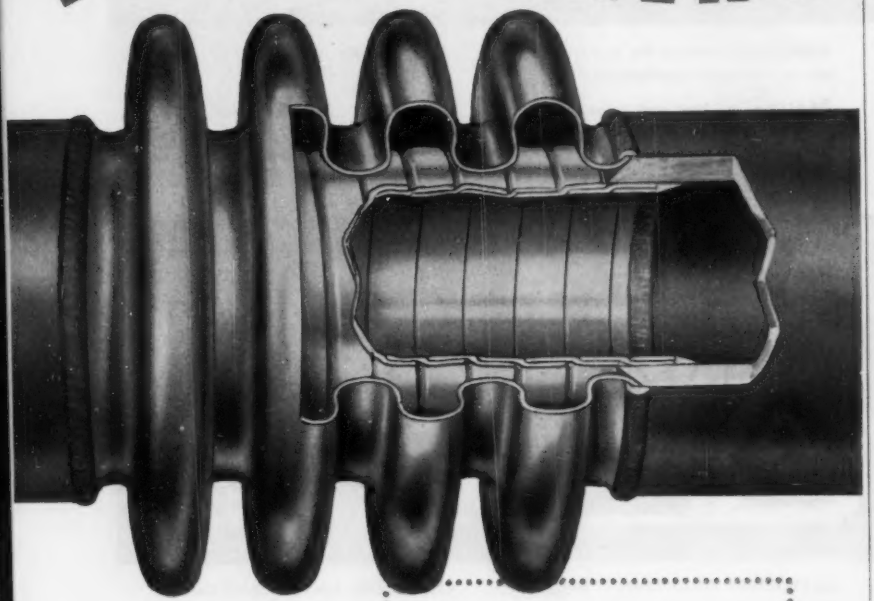
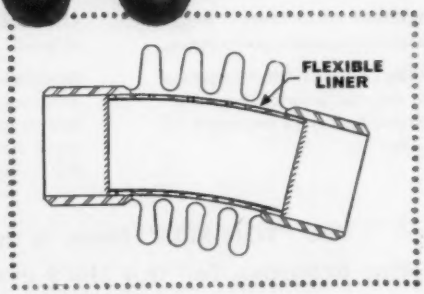
REMEMBER OIL PROGRESS WEEK—OCTOBER 12th to 18th

Flexon®

EXPANSION JOINTS *NOW* WITH

FLEXIBLE LINERS



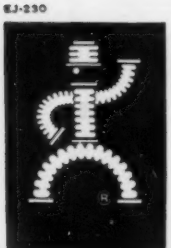


Lateral or angular motion without flow reduction of conical type liners

No more need to specify oversize expansion joints to allow for the flow reduction through an ordinary conical liner! Now you can get Flexon Expansion Joints with flexible liners that give full flow. Easier to install, too, because flow can be in either direction. A section of smooth interior, Flexon stainless steel hose forms the liner—cuts flow turbulence, reduces carrier temperature and permits full pipe movement either laterally, angularly, or axially. The cost is no more than for conical sheet liners.

Write today for facts about this new Flexon development—and your copy of the 28-page Flexon Expansion Joint Design Guide, the complete handbook for solving every problem in pipe motion.

EJ-230



Flexonics corporation

EXPANSION JOINT DIVISION • 1336 S. THIRD AVENUE, MAYWOOD, ILLINOIS

EXPANSION JOINTS · METAL HOSE · NON-METALLIC HOSE · BELLOWS · AIRCRAFT COMPONENTS

Who's Building...

tect the water from being made less pure by contact with the metal tank shell.

Made by the Graver Water Conditioning Co. of New York, the water treatment plant was installed under the supervision of Bechtel Corp., general contractor on present construction at the refinery.

Malco Refineries, Inc., has started up a new alkylation unit at Artesia, N. M. Charge capacity is 1056 bpsd. The units product has tested out at 102 research octane, leaded, according to refinery officials. The alkylate will be used for motor fuel octane improvement.

The unit, designed, engineered and licensed by Universal Oil Products Co., is designed to produce 115/145 aviation grade fuel, if desired.

The Bay Refining Co., a Dow Chemical Co. subsidiary, will build a hydrofluoric alkylation unit at its Bay City, Mich., refinery. The unit will have a 750-bpd capacity and will use the Universal Oil Products Co. process. Site preparation and foundation work began early in September, and completion of the unit is scheduled for June, 1959.

Southwestern Engineering Co. has contracted for both the engineering and construction of the plant.

British-American Oil Co.'s 5,400-bpd catalytic reforming unit at Moose Jaw, Canada, is complete. It will not increase capacity of the refinery but will upgrade gasoline already being produced.

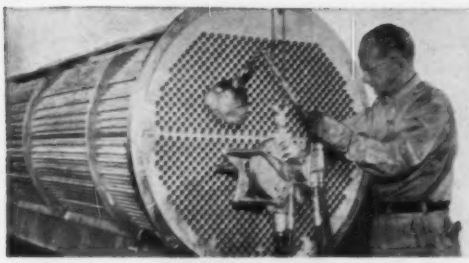
A naphtha desulphurization unit removes sulphur from straight-run gasoline before it enters the catformer where, with the help of a platinum catalyst, high octane reformate is produced for premium gasolines. A gasoline splitter divides the gasoline into two parts for better blending.

The Lummus Co. of Canada, Ltd., is the major contractor on this project, building both the naphtha desulphurizer and catalytic reformer. The gasoline splitter was constructed by Procon (Canada) Ltd. Extensive tankage and piping facilities, also being added to the refinery, were designed by B-A.

Chemische Werke Huels, A.G. has completed a new dehydrogenation process unit, designed to produce 36,000 metric tons per year of butadiene for synthetic rubber, in Marl, West Germany. The process produces butadiene from refinery butanes and butane-butene mixtures.

The West German unit is the first of three Houdry licensed foreign dehydrogenation plants to go on stream. Others are under construction in Japan and Italy. Process design for the new unit was provided by Houdry, and construction was managed by Chemische Werke Huels.

The Standard Oil Co. (Ohio) has begun operation of its new $40 million Toledo, Ohio, refinery. It will add about 25 percent to the company's existing crude oil capacity and double the capacity it had ten years ago, producing regular and premium gasolines, special naphthas, liquefied petroleum gas, kerosine, furnace oil, diesel fuel, jet fuel, aviation gasoline, heavy fuel and petroleum coke. Operations throughout the facility are coordinated through a central communications and control system supplemented by eight separate satellite control houses. Telephones, loud speakers and a walkie-talkie will keep



CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, N. Y.

Duplex Tubes handle dual corrosion problems —or unusual pressure-temperature conditions

Anaconda Duplex Tubes are special-purpose products designed primarily to meet requirements involving dual problems of corrosion. They are usually made by drawing tubes of copper or a copper alloy either inside or outside of steel tubes. However, they can be furnished in any combination of components, including copper or copper alloys with other nonferrous metals or steel, in a wide range of diameters and wall thicknesses.

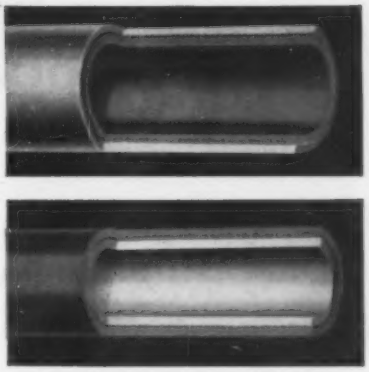
A Duplex Tube of steel with copper or a copper alloy inside is used, for example, in exchangers or condensers handling water in the tubes and ammonia or a fluid with appreciable amounts of ammonia in the shell. Moist ammonia attacks copper and all of its alloys, and may cause stress-corrosion cracking. Steel, however, is not susceptible to such action by ammonia. Thus, the nonferrous tube is shielded and can perform its normal function of giving long service life and efficient heat transfer on the "water side."

Other combinations of coolant—or heating fluid—and "stream" are found in petroleum refineries and chemical plants, in which differing properties are required inside and outside an exchanger tube. Here, two nonferrous metals may be combined—a Cupro Nickel and Admiralty, for example.

For extra strength. Anaconda Duplex Tubes can also be used in those applications where internal or external pressures—or the pressure-temperature combinations—are too great for a nonferrous tube alone. In this case, the nonferrous tube is selected for the chemical properties required for the more corrosive fluid handled; and the steel tube gives the needed strength.

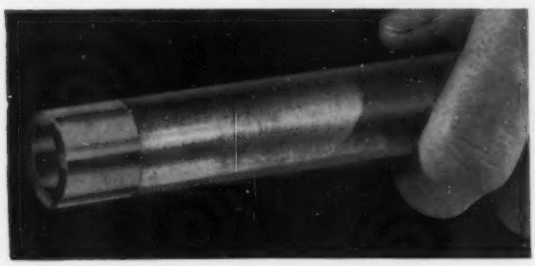
Heat transfer properties. The fabricating method by which Anaconda Duplex Tubes are manufactured assures a tight mechanical bond between the outer and inner components of the tube. This tight mechanical bond assures no significant loss of heat transfer across the interface between the two components of the duplex tube. With duplex tubes, copper and steel or copper alloy and steel, the heat transfer will be definitely superior to that of a solid steel tube of the same total wall thickness regardless of which metal is inside or outside.

U-bends. The compact U-bend tube design in heat exchangers has many advantages, particularly where wide temperature differences exist in the unit. And Duplex Tubes can be readily bent to form the hairpin or U-bend tubes required—in the longer lengths now becoming increasingly popular.



Duplex Tubes are made by drawing copper or copper alloy tubes either inside or outside of steel tubes—or of tubes of a different copper alloy.

Technical Assistance. Specialists at The American Brass Company are constantly working with manufacturers and users of heat exchange equipment, helping to solve process problems. This experience is available to you. For more detailed information on Duplex Tubes, U-bend Tubes, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5877



Duplex Tubes can be furnished with the outside tube cut back to be replaced by a ferrule of the same composition as the inside tube—to avoid galvanic corrosion.

ANACONDA®

TUBES and PLATES for CONDENSERS & HEAT EXCHANGERS

Made by THE AMERICAN BRASS COMPANY

BETTER AIR CONDITIONING FOR EVERYBODY EVERYWHERE

Carrier

Carrier multi-level refrigeration

saves $60,000 in installation costs!

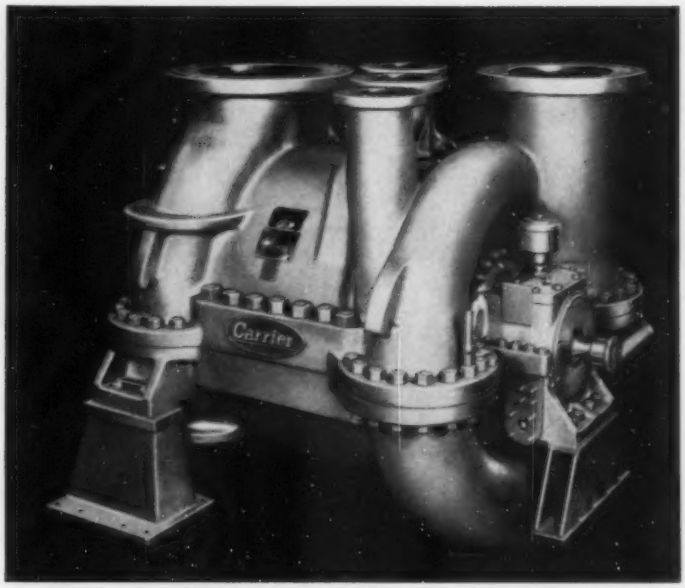
Problem: To provide propane refrigeration at four temperature levels—minus 35° F, minus 3° F, plus 28° F and plus 64° F—in a southwestern natural gas extraction plant.

Conventional solutions: (a) Install four separate compressors. (b) Install two compressors. (c) Install one compressor with no side loads.

Carrier solution: Install a single Carrier Centrifugal Compressor with side loading.

Installation savings: Savings on the installed cost of the single Carrier Centrifugal, exclusive of drivers and their installation costs—in comparison with the conventional solutions (a) $60,000. (b) $28,000. (c) No installation savings, but note big horsepower savings below.

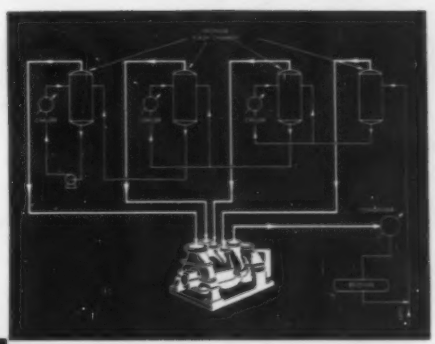
Horsepower savings: Power savings resulting from use of the Carrier Centrifugal—in comparison with (a) none. (b) 1230 hp. (c) 3400 hp.

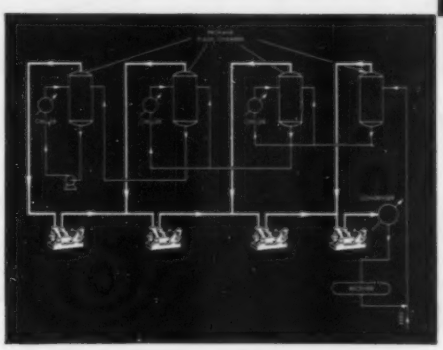


Multi-stage, heavy-duty Carrier Centrifugal Compressors with broad application flexibility are available in capacities up to thousands of tons, depending on your requirements.

Now you can effect substantial savings in horsepower and installation costs by using a single Carrier Centrifugal Compressor for refrigeration in many processing applications. These multi-stage, heavy-duty compressors provide definite installation and operating advantages. For example. Side loading for split load requirements. Extreme flexibility of arrangement with coolers and condensers. High lift or wide temperature range in two to nine stages. Variable inlet guide vanes for capacity control. Suitable for all types of drives. Versatile use with any high-pressure refrigerant.

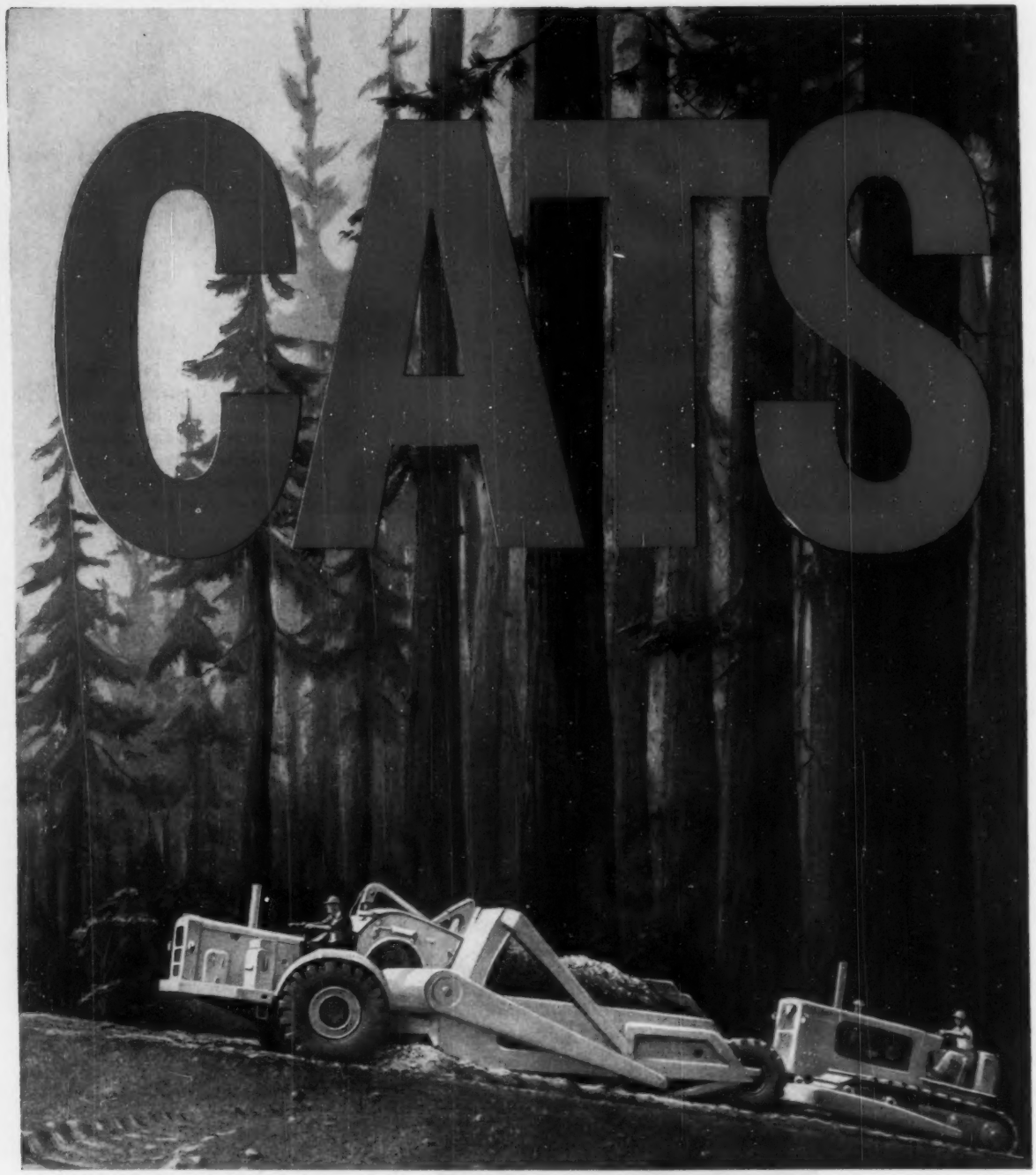
These big-tonnage compressors are built to the same high-quality standards that have earned Carrier the reputation for round-the-clock dependability in thousands of installations. Carrier specialists draw on experience unmatched in the field. For specific recommendations for your requirements, call the Carrier office nearest you. Or write Carrier Corporation, Syracuse 1, New York.





In a natural gas extraction plant in the Southwest, one Carrier Centrifugal Compressor handling four gas streams with side loading accomplishes the same results as four separate compressors. Compared with the conventional installation, savings on installed cost of the Carrier unit totaled about $60,000, exclusive of driver installation costs.

For more data on advertised products, use Readers' Service Cards, last page.



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key men in constant touch with each other.

Continuous processing and efficient heat exchange system will mean substantial savings in heat and cooling costs. The unit will generate most of its own fuel for heat and power, thus eliminating excess storage capacity. It will create nearly 300,000 pounds of steam per hour, requiring 40,000 gallons of fresh water per minute.

Contractor for the project was The M. W. Kellogg Co.

The Carter Oil Co. is converting a bauxite desulphurizer into a naphtha distillate hydrofiner at its 34,000 bpd refinery in Billings, Mont. Capacity of the hydrofiner will be 10,275 bpd, and the desulphurizer has a 9,220-bpd capacity.

The job is part of a multimillion-dollar expansion program at Billings, being handled by The Refinery Engineering Co., Tulsa. Treco is also prime contractor on a 2,000-bpd alkylation unit and a light ends debutanizer going in at Billings. Construction of these units started September 8. All units, including the revamp, are scheduled for completion early in the second quarter of 1959.

Carter is handling most of the process engineering, with Treco responsible for mechanical engineering, purchasing, construction, and part of the process engineering. Treco also handled design and engineering on the alkylation unit and debutanizer. The alky unit is licensed by Universal Oil Products Co.

Chinese Petroleum Corp. has awarded Badger Manufacturing Co. a contract for the design, engineering and equipment supply of a sulphuric acid alkylation plant to be built at Kaohsiung, Taiwan, China. The plant will produce 600 bpd of high octane aviation alkylate initially, with ultimate future capacity up to 1000 bpd, and will greatly increase the production on Taiwan of 100/130 and 115/145 octane aviation gasoline.

The new plant, scheduled for completion in early 1959, will utilize a process licensed by Texaco Development Corp. The process plant provides for extensive fractionation of the alkylate.

All process equipment will come from the U. S., except a few items being supplied through a Badger subsidiary. Chinese Petroleum's construction superintendent, maintenance and inspection engineers and plant operators, will be trained in the U. S.

Esso-Raffineriet A/S will build an oil refinery at Slagen, near Tonsberg, on the western side of Oslo Fjord. The refinery will have a 40,000 bpd capacity.

Brazil reports that $49 million is expected to be invested in its proposed synthetic plant to be located at Caxias. About 70 percent of these funds will be in foreign currency.

The plant is expected to begin initial production in Sept., 1959.

Monsanto Chemical Co.'s Lion Oil division refinery at El Dorado, Ark., is planning a major expansion. The program will increase the rated crude oil thruput capacity of the refinery from 29,000 to 33,000 bpd. It will also include construction of new hydrodesulphurization, decarbonization and tetramer units, and en-

Dropped from a height of 40 feet, a 3,000 pound weight destroyed an ordinary cast iron valve body, yet barely dented a STANCO Ductile Iron Body — proof positive of the greater strength of STANCO Ductile Iron Valves.

Greater strength, however, is just one of the many unique advantages of STANCO Ductile Iron Valves. They possess corrosion resistance equal to that of cast iron, elevated temperature strength comparable to that of ordinary cast steels, and thermal shock resistance equal to that of cast carbon steels. And they are *pressure tight* — ductile iron has a metallographic structure which resists leakage or seepage by liquids and gases.

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Every step in the manufacture of STANCO valves is carried out under one roof. From the patterns through the various stages of casting, heat-treating, machining, assembly and testing, Standard Brass and Manufacturing Co. provides a single, undivided line of responsibility.

These revolutionary valves are making possible substantial savings for many users. May we send you complete information?

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For information about 1025 steel and for your commercial forging requirements, write to Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, New Jersey.

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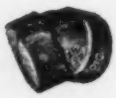
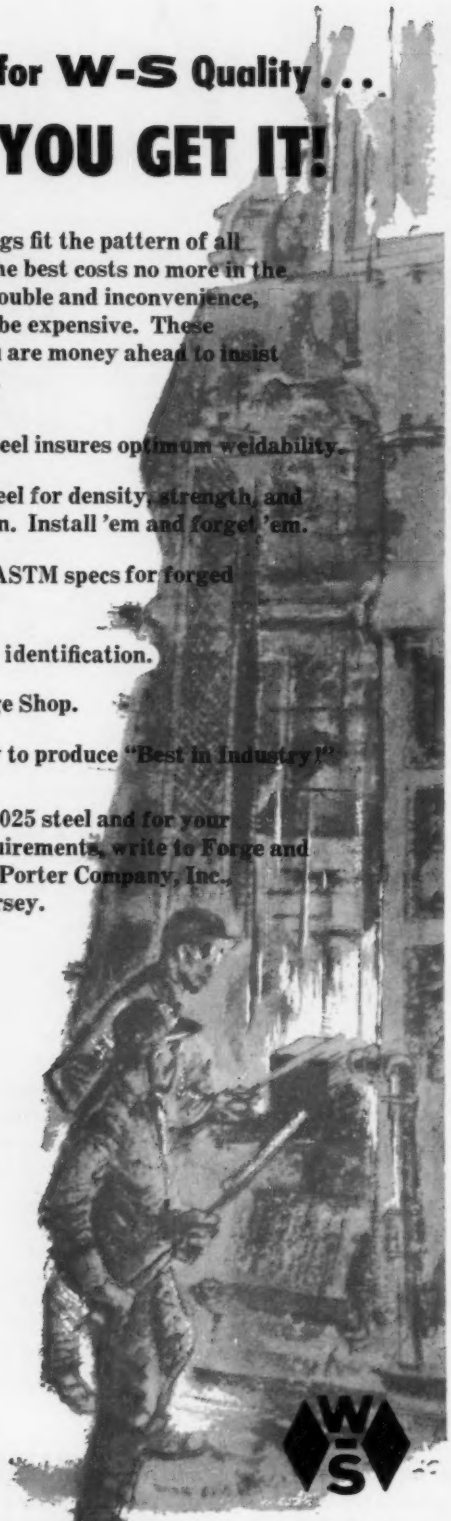


ROUGH FORGING AFTER TRIMMING

FINISHED FITTING



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W-S Fittings Works, Roselle, N. J. • Cleveland Forge Works, Cleveland 4, Ohio
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largement of existing vapor recovery facilities.

The hydrodesulphurization unit has a 5,000 bpd capacity. The decarbonization facilities, also to have a 5,000-bpd capacity, will increase the yield of paving-grade asphalts through the upgrading of low-priced residuals.

Engineering and purchasing work has begun and completion of construction is expected early in 1960. The 5,000-bpd catalytic reformer which was begun last April is nearing completion.

The Anlin Co. of Illinois is building a 150-ton a day plant, which will recover sulphur from hydrogen sulphide, adjacent to Shell Oil Co.'s Wood River, Ill., refinery. It will cost about $2 million. Construction has begun and completion is scheduled for mid-1959.

Anlin will own and operate the plant, and Shell, under a working agreement with Anlin, will supply the plant with its basic feed stock (hydrogen sulphide) from which Anlin will extract elemental sulphur.

There will be two chief advantages to the operation. One is the recovery of a basic and important raw material. The other is purification of plant by-products which eliminates smoke and fumes.

Shell emphasized that the plant is a continuation of the company's air and stream pollution abatement policy in all areas where company installations are located.

Chemical Engineering Associates will handle process engineering and design of the facilities. The construction contract has been awarded to Industrial Gencon, Inc.

Celanese Corp. of America plans to double the capacity of its acetic acid plant at Pampa, Texas. Work on the multi-million dollar expansion is scheduled to begin this year and to be completed by late 1959. Addition of the new facilities will enable the Pampa plant to produce 240 million pounds a year, or 15 percent of the nation's total requirements for acetic acid. Combined capacities of the Celanese plants at Pampa and Bishop,

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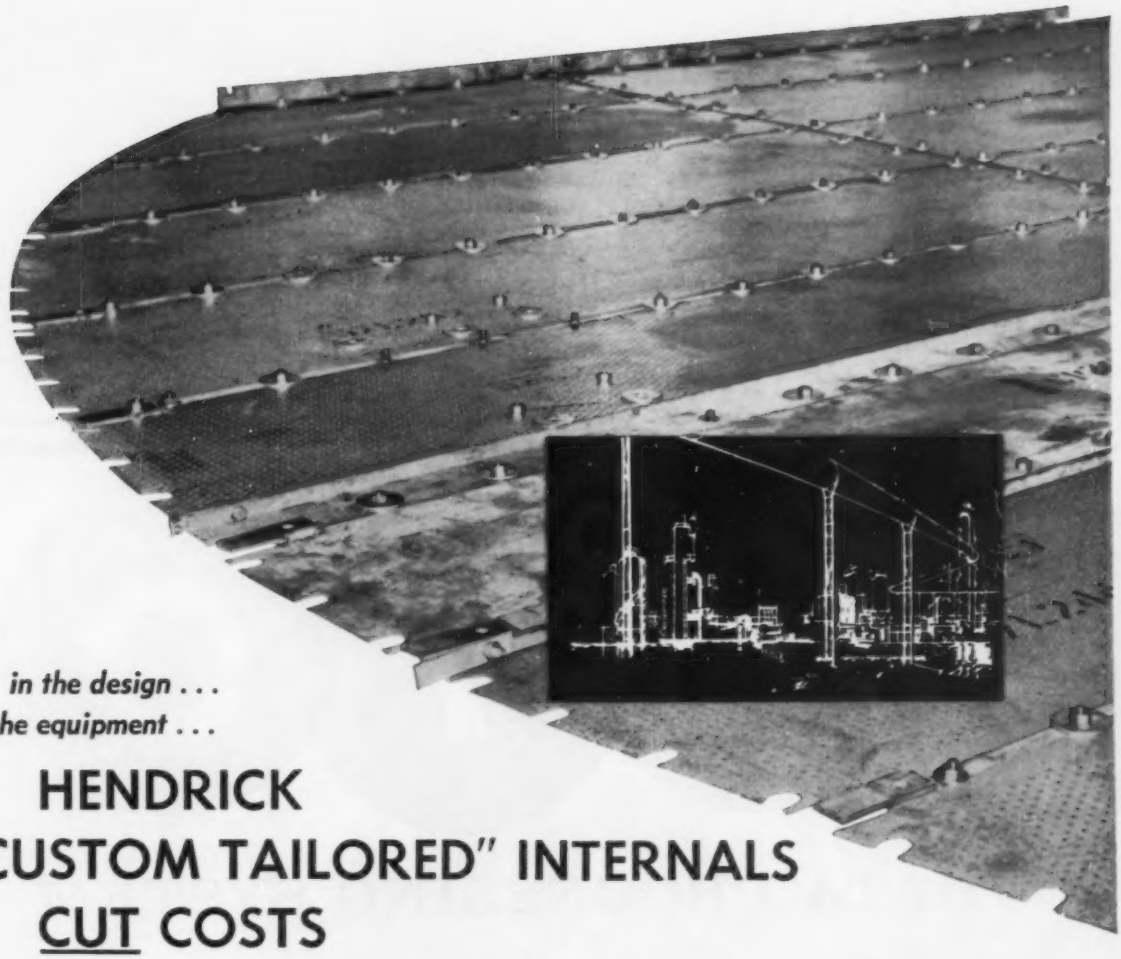

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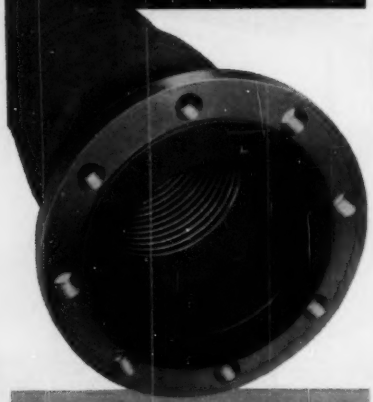

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Texas, will give the company more than one-quarter of the nation's acetic acid capacity, according to the company.

The Pampa plant began operation in 1952, and has been expanded several times since. Contributing to the increased capacity will be new high-volume centrifugal compressors and major alterations to purification units.

The acetic acid produced also will be available for increasing output of products used in the manufacture of polyurethane foamed plastics, coatings and synthetic lubricants, and acrylate esters.

Asahi-Dow, Ltd., is building a new styrene monomer plant at Tokyo Bay's refining and petrochemical center in Kawasaki, Japan. The plant, slated to go on stream early in 1960, will supply existing raw material needs for polystyrene production in Japan, with additional capacity available for synthetic rubber production. Construction will be partially supervised by Dow Chemical Co.'s Plastics Production department.

Gulf Oil Corp.'s Port Arthur refinery has contracted with The Babcock & Wilcox Co. for the manufacture and installation of a carbon-monoxide-fired boiler. Slated to adjoin the refinery's newest fluid catalytic cracking unit erected in 1956, the CO boiler will recover 400 million btu's of heat per hour from the high temperature gases produced by the cat cracker. This amount of heat is reported to be the greatest ever recovered by a single unit from catalytic gases, which ordinarily go to waste. Also, the cracking unit, which has a rated capacity of 62,500 bpd, will be one of the two largest in the world equipped with a CO boiler, according to the company.

Designed for a pressure of 825 pounds per square inch, the boiler will have an operating pressure of 710 psi with a steam temperature of 675 F. at the superheater outlet. It will have a normal steam flow of 400,000 pounds per hour while utilizing the 800,000 pounds of gas discharged from the regenerator at more than 1000 F. The unit is slated for completion in mid-1959.

Breaux Bridge Oil Refining Co. is planning a new oil refinery, to be built in Guatemala. It will be the first such project in Central America.

Initial capacity of this refinery will be about 3,500 bpd, costing $3½-4 million. Breaux Bridge intends to form a separate company in which the Royal Dutch Shell group of oil companies and the Canadian Eagle Oil Co. have agreed to participate. The common equity will be divided equally between Breaux Bridge and the Shell Eagle interests.

At present, about 19 companies are exploring for oil in Guatemala. Construction of this refinery may be considered an extension of these activities in that it may lead to an integrated petroleum industry in Guatemala, if and when oil is discovered there. Arrangements have already been made with Shell Associates for the supply of crude oil.

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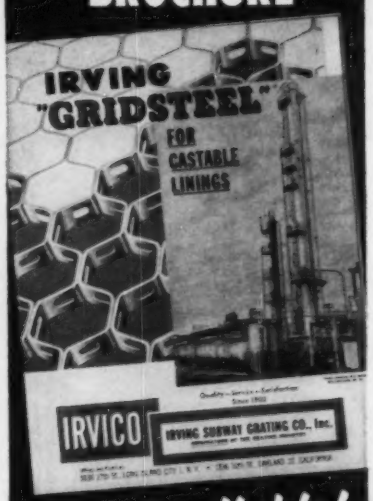

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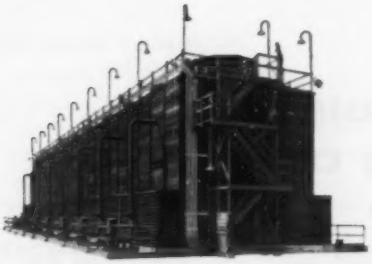
The Old Timer has a point. And, until now, he was forced to abide by it – forced to buy in the dark and pay the penalty of over-buying to protect his company. But there's been an important change. Now, for the first time, all of the information needed to determine counterflow cooling tower performance is available in one easy-to-use handbook.



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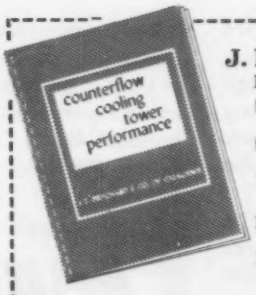

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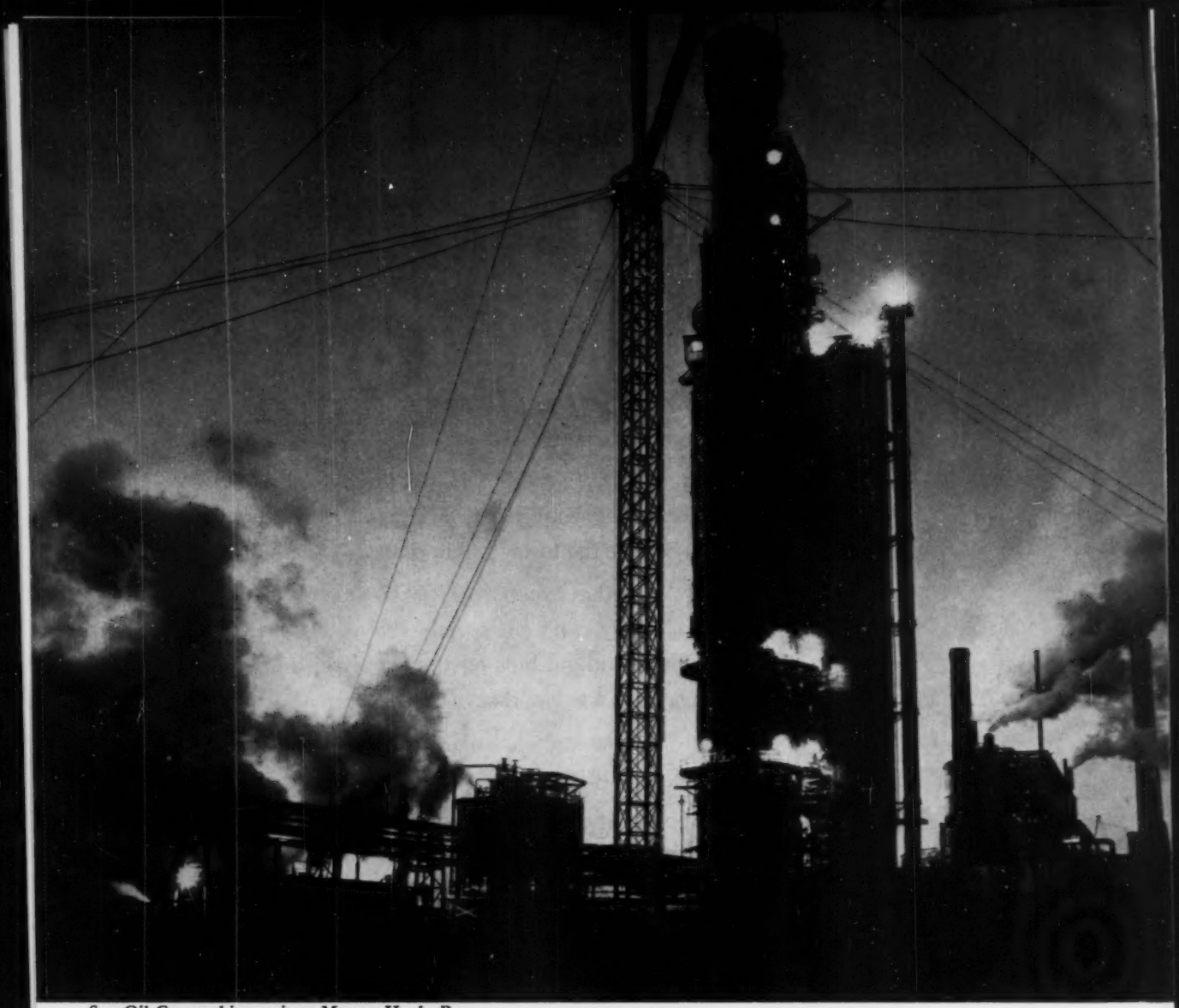

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B&W Carbon Monoxide Boilers in oil refineries are compiling outstanding records. The twelve units already on stream have produced, since 1953, savings of millions of dollars in fuel costs. And every day they are in operation, they continue to save money. Each of these boilers is quickly paying for itself. No wonder a total of 18 units has been ordered to date.

Big fuel savings are achieved because B&W "CO" Boilers put sensible and combustible heat to work. In extended, sustained service they have proved their efficiency, reliability, and economy.

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B&W engineers, experienced in meeting differing refinery conditions, can design a B&W "CO" Boiler to fit your specific requirements, for any steam pressure and temperature, for any size cracking unit. Write for Bulletin G-87. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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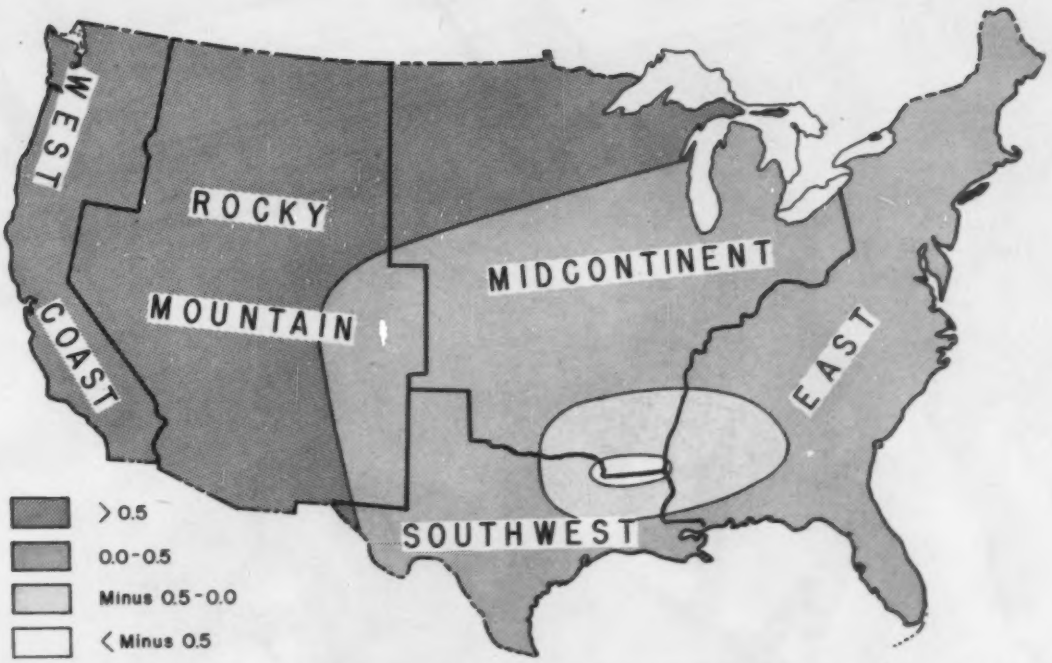


FIGURE 1—Increase in F-1 octane numbers of premium grade gasoline for year preceding August, 1958 (Source: Ethyl Corp.).

"Construction Boxscore" data reveal . . .

Octanes Show Reforming Influence

Although reforming capacity skyrocketed last year, octanes held steady. Here's why!

Clayton A. Umbach, Jr.
Petroleum Refiner Staff

In spite of the frequently prophesied and much talked about "octane race," the trend to higher and higher octanes has failed to materialize this year. As a matter of fact the overall octane picture in the U. S. is steady as a rock with actual octane numbers unvarying from month to month. For the sixth straight month, Premium fuel has held to the national average of 98.1 F-1 while regular has leveled out at 91.2 F-1.

It seems strange that this is true even though during the past 12 months a terrific amount of reforming capacity has been put on stream in this country. Since one of the primary reasons for installing reforming capacity is to get higher octanes, it would seem this increase in reforming should give a steady increase in the national average of octane numbers. However, this has not been the case!

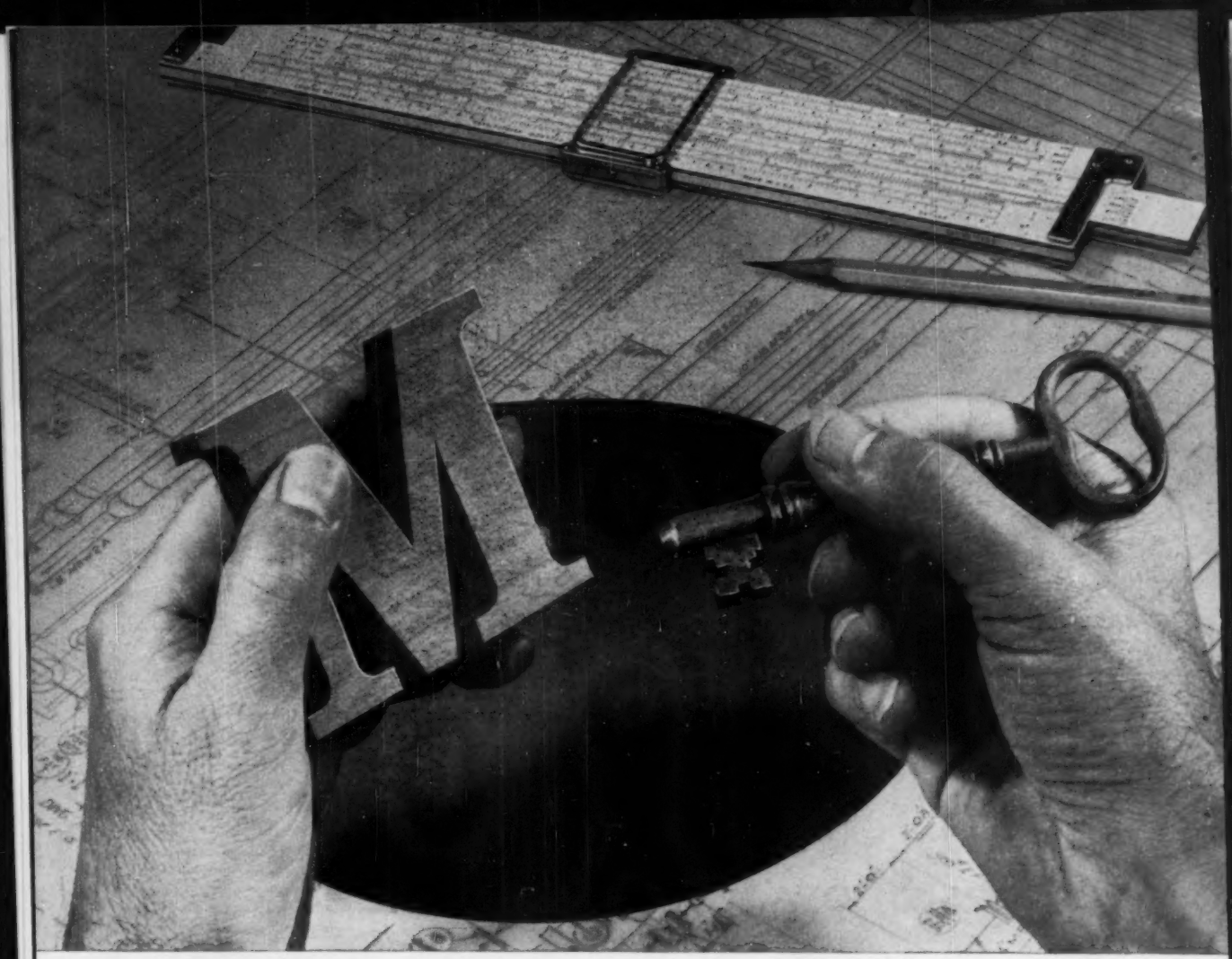
A quick look at Figure 1 will tell you the octane story for portions of the country during the past 12 months. You can see that the West Coast, most of the Rocky Mountain, and a portion of the Midcontinent areas increased by one-half of one octane number or higher. The highest marked up was a 1.8 hike at Billings, Mont.

The rest of the nation had varying increases up to one-half of one octane with the exception of one portion which actually recorded a decrease. This decrease ran as much as one-half of one octane.

To show you how this compares with last year, "Construction Boxscore" in the October, 1957 issue of PETROLEUM REFINER recorded an increase of three octane numbers in one section of the country. A slightly larger section showed a gain of from two to three numbers while the greatest portion of the country increased anywhere from one to two numbers.

At that time, PETROLEUM REFINER pointed out that the increases in octane numbers was directly related to the increases in reforming capacity. That is, the section which had the greatest reforming gains also recorded the greatest gains in octanes.

There is still a correlation between the two, even though this year the increases are only slight. Figure 2 divides the U. S. and shows the reforming capacity which has been added during the 12 months preced-



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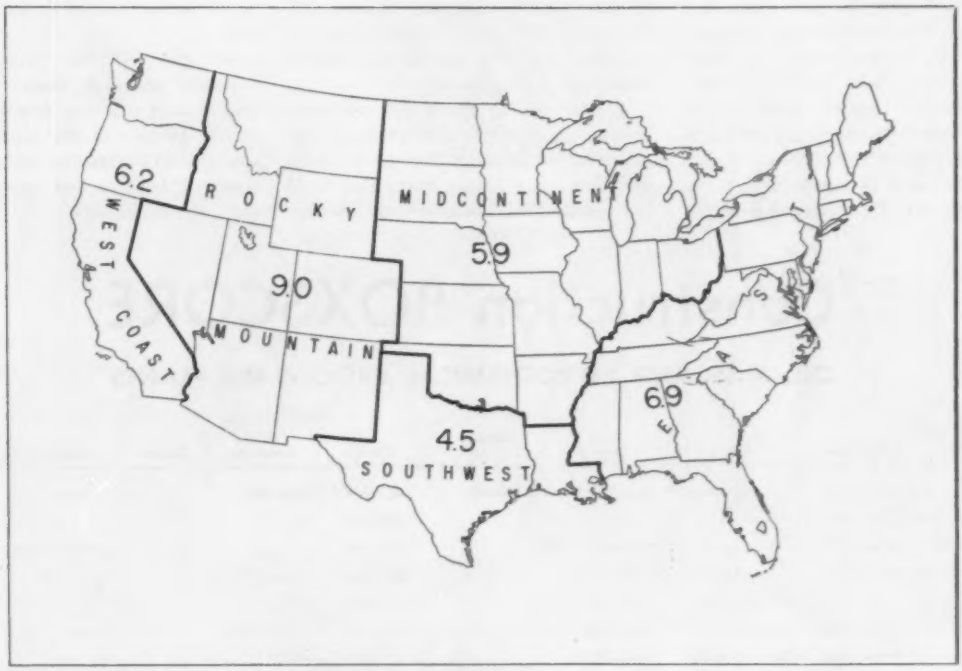


FIGURE 2—Reforming capacity installed for the year preceding July, 1958 reported as percentage of crude runs to stills for each "Construction Boxscore" area.

ing July, 1958. This is based on the new reforming as a percentage of the crude running capacity in each individual area.

You can see that those sections of the country which recorded the least reforming increase also saw the least octane increase. For instance, the Southwest area which had the least increase was the area in which the octane decline showed up.

There is yet another conclusion which we may draw from these figures as presented in "Construction Boxscore." That is, that this country has finally reached the point where more reforming capacity does not substantially alter the average national octane number. The octanes are already so high that we have to bring a terrific amount of reforming on stream to even raise the national average slightly.

Now, with all of this new reform-

RECENT REFORMING UPSWING NOW LEVELING OFF

Construction Boxscore Areas	Average Crude Run To Stills* Thousands of BPD	Reforming Capacity Installed Thousands of BPD			
	Jul. '57-Jul. '58	Jul. '57-Jul. '58		Jul.-Oct. '58	After Oct. '58
East	1,363	94.2	(6.9)**	0.0	10.0
Mid-Continent	2,247	133.5	(5.9)	6.0	44.2
Southwest	2,636	119.0	(4.5)	26.0	39.0
Rocky Mountains	295	26.6	(9.0)	0.0	0.0
West Coast	1,092	68.0	(6.2)	21.3	13.3
Total	7,633	441.3	(5.8)	53.3	106.5

* U. S. Dept. of Interior, Bureau of Mines.
** Numbers in parentheses are percentages of crude run to stills.

ing added during the past year, just where does the total reforming capacity of the U. S. stand today? Through the continuing check that "Construction Boxscore" makes quarterly to each company in the U. S. which is doing any type of construction within the oil, gas and petrochemical processing industry, PETROLEUM REFINER is able to show that as of this month, October, 1958, reforming capacity within the continental United States stands at 1.83 million bpd.

The figures in Table 1 reveal that another 106,000 bpd have been announced for construction to be completed at some future date. This total is broken down to give you an idea as to where the new units will be built.

In spite of this new reforming capacity planned, however, we still feel that it will not greatly alter the octane picture in this country. If refiners want octanes to continue to rise they will have to look beyond reforming—to alkylation.

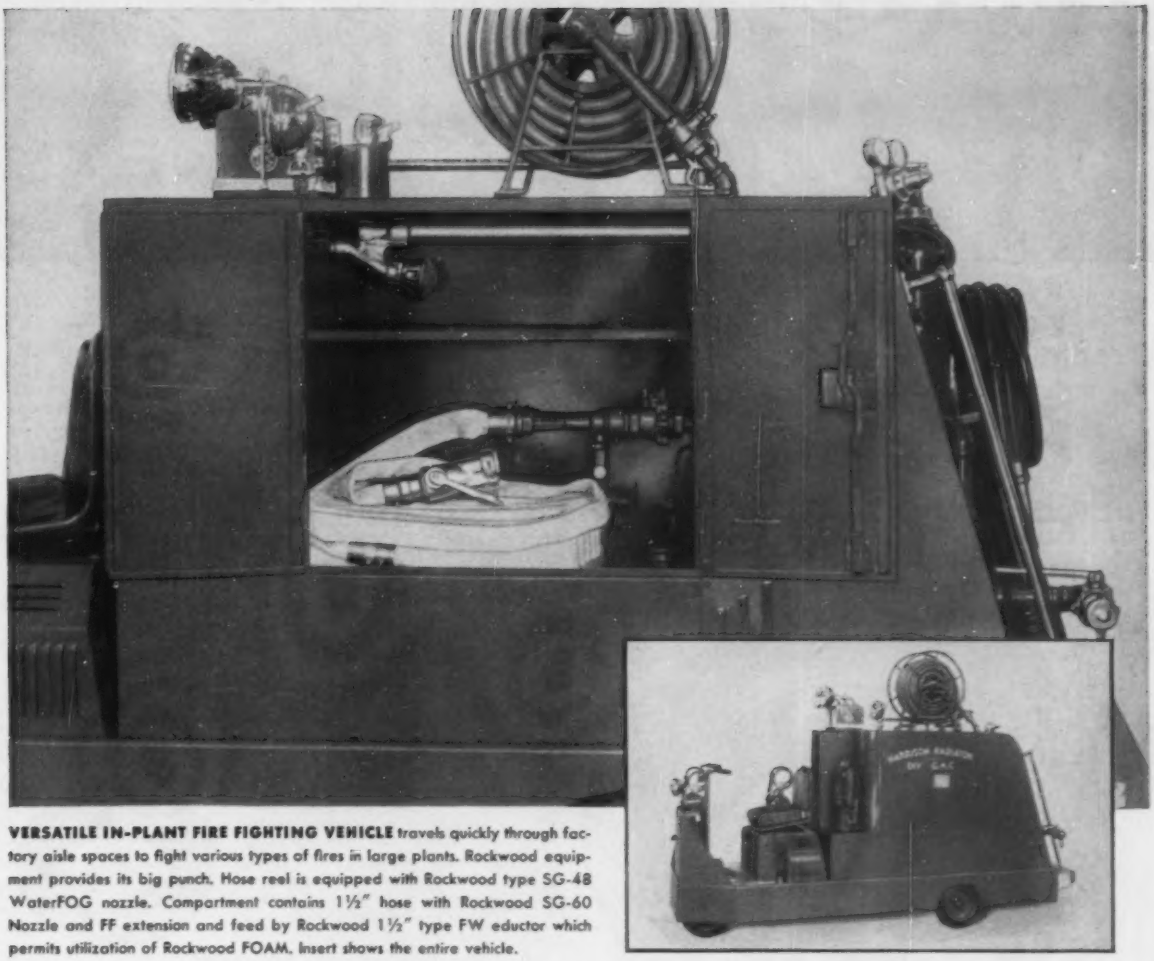
Construction BOXSCORE

OIL, GAS AND PETROCHEMICAL PROCESSING PLANTS

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Air Reduction	Calvert City, Ky.	Polyvinyl Alcohol Resin Plant	20,000,000 lbs/yr	$12,000,000	Under Constr.	Early 1960	.....	Lummus	Lummus
Allied Chemical & Dye	Buffalo, N.Y.	Polyethylene	.....	.....	Under Constr.	Late 1958	.....	.....	.....
American Cyanamid	Bridgeville, Pa.	*Maleic Anhydride	14,000,000 lbs/yr	.....	Under Constr.	.....	Scientific Design	Scientific Design	Scientific Design
Atlantic Refining	Philadelphia	*Vacuum Flash Unit	40,000 bbls.	.....	Under Constr.	Spring, 1959	.....	Hydrocarbon Research	Hydrocarbon Research
		*Revamp Visbreaker	20,000 bbls.	.....	Under Constr.	Spring, 1959	.....	Atlantic/Hydrocarbon	Atlantic/Hydrocarbon
California Oil Co.	Perth Amboy, N.J.	Cat. Reformer	10,000 bbls.	.....	Under Constr.	4th Qtr. 1958	.....	Ferguson	Ferguson
Chemstrand	Decatur, Ala.	Exp. Acrilan Plt.	45,000,000 lbs./yr.	.....	Under Constr.	1958	.....	Staff, et al	Davis Constr.
Cities Service	Linden, N.J.	Refinery Modernization	14,000 bbls.	$10,000,000	Complete	.....	.....	Braun	Braun
		Asphalt Plt.	.....	$8,000,000	Complete	.....	.....	Braun	Braun
Columbia Hydrocarbon	Siloam, Ky.	Hydrocarbon Fractionation Plt. with pipe line and offsite facilities	230,000,000 gal./yr.	$5,000,000	Under Constr.	Dec. 1958	.....	Pritchard	Pritchard
Commerce Oil Ref.	Jamestown, R.I.	Refinery:	40,000 bbls.						
		Crude Units	25,000 bbls.	$50,000,000	Engineering	.....	UOP	Fluor	Fluor
		Cat. Cracking	.....						
du Pont	Belle Works, W. Va.	Urea; Ammonia Methyl Methacrylate, Nylon Intermediates	.....	.....	Planned	1959	Texaco	.....	.....
	New Jersey	Hydrogen Plant	.....	.....	Engineering	Late 1958	.....	Chemico	Chemico
Esso Standard	Bayway, N.J.	Hydrofiner	15,000 bbls.	.....	.....	.....	.....	.....	.....
Food Machinery & Chemical Corp.	S. Charleston, W.Va.	Exp. Carbon Tetrachloride Plt.	.....	.....	Complete	.....	.....	Staff, Fluor	Fluor
Goodrich-Gulf Chem.	Institute, W.Va.	Rubber Production Exp.	.....	$1,000,000	Under Constr.	.....	.....	Girdler, Staff	Girdler
Gulf Oil	Near Charleston, S.C.	Refinery	.....	.....	Considering	.....	.....	.....	.....
Koppers	Woodbridge, N.J.	Polyethylene	30,000,000 lbs./yr.	.....	Complete	.....	.....	Koppers	Koppers
National Cylinder Gas Company	Conshohocken, Pa.	*Liquid Oxygen	50 tons	.....	Under Constr.	Late 1958	.....	Hydrocarbon Research	Hydrocarbon Research
Reichhold Chemicals	Hampton South Carolina	Formaldehyde Plant	30,000,000 lbs./yr.	.....	Engineering	1958	.....	.....	.....
	Tuscaloosa Marcus Hook.	Formaldehyde Plt.	35,000,000 lbs./yr.	.....	Planning	.....	Staff	Staff	Staff
Socono Products	Hartsville, S.C.	*Acid Recovery Unit	265 tons	.....	Complete	.....	.....	Vulcan	Vulcan
Socony Mobil	Paulsboro, N.J.	Alkylation	2,440 bbls.	.....	Under Constr.	.....	.....	Kellogg	Kellogg
		Delayed Coker	19,000 bbls.	.....	Engineering	Early 1959	.....	.....	Lummus
		Sulfur Recovery Plt.	.....	$700,000	Under Constr.	Fall, 1958	.....	Badger Mfg.	Badger Mfg.
Spencer Chemical	Henderson, Ky.	Urea Plt.	100 tons	.....	Under Constr.	Summer 1958	Montecatini	Staff	Quaker Valley
Sunshine States Refineries	East Tampa, Fla.	Refinery	20,000 bbls.	$27,000,000	Under Design	1959	.....	Kaiser	Kaiser
Union Carbide Chemicals	Institute, W.V.	Exp. Acrylonitrile Plt.	.....	.....	.....	1958	.....	.....	.....
	Winfield, W.V.	Petrochemical Plt.	.....	.....	Planning	1960	.....	.....	.....
United Fuel Gas Co.	Kenova, W.V.	Hydrocarbon Extraction Plt.	.....	$8,000,000	Under Constr.	Dec., 1958	.....	Pritchard	Pritchard
United Refining	Warren, Pa.	Refinery Exp.	15,000 bbls.	$1,250,000	Under Constr.	.....	.....	.....	.....
MID-CONTINENT									
American Potash	Aberdeen, Miss.	*Sodium Chloride Plant	.....	.....	Under Constr.	Fall 1958	.....	Braun	Braun
Amoco Chemical	Joliet, Ill.	Phthalic Anhydride Isophthalic Acid, Terephthalic Acid, Diemthyl Terephthalate, Dimethyl Isophthalate Benzoic Acid	60,000,000 lbs./yr.	$10,000,000	Under Constr.	Oct. 1958	.....	Scientific Design	S. D. Plants
		Aromatic Acid Plt.	.....	.....	.....	.....	.....	Catalytic	.....
Anderson-Prichard	Arkansas City, Kans.	H. F. Alkylation	2,250 bbls.	.....	Complete	.....	UOP	UOP; Treco	Treco
Aurora Gasoline Co.	Detroit	Vacuum Unit	18,000 bbls.	.....	Under Constr.	Early 1959	.....	Treco	Treco
Bay Refining Co., Division of Dow Chemical	Bay City, Mich.	Crude Unit	12,000 bbls.	$900,000	Engineering	.....	.....	Sweco	Sweco
		*Butylene/Alky. Unit	850 bbls.	$850,000	Under Constr.	Early 1959	UOP	Sweco	Sweco
Callery Chemical	Muskogee, Okla.	Hydrogen Plt.	800,000 scf	.....	.....	.....	.....	.....	.....
		Nitrogen Plt.	200,000 scf	.....	Complete	.....	.....	Girdler	Girdler
		Carbon Dioxide	7,790 lbs./hr.	.....	.....	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 175



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THEY ARE ENGINEERED TO ASSURE

- **Positive sealing with minimum flange bolt loading**
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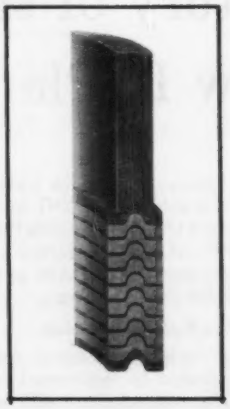
- **Reduction of corrosion, thus giving longer life and service**
- **Elimination of a necessity for ground or lapped flanges**

"Spiroflex" gaskets are manufactured from spirally wound strips of 18-8 vee-formed stainless steel with an inlay of special filler material between each turn. This construction is capable of infinite variation as the number of metal plies in relationship to the filler plies can be increased and decreased and the filler material itself varied to suit practically any service conditions.



TYPE GR

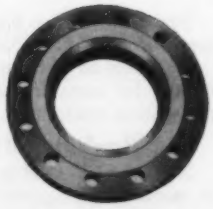
The type GR gasket consists of a standard spiral-wound ring inserted in a solid metal guide which serves as a centering device, prevents lateral expansion and eliminates excessive strain.

TYPE WL

"Spiroflex" WL gaskets are supplied with wing-shaped location guides of the same formation and metal as the gasket itself and give excellent service in pressure ranges up to and including 900 PSI.

TYPE RF

"Spiroflex" type RF gaskets are designed to seat within the bolt circle and are especially constructed for use in both tongue and groove and male and female flanges.



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CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Carter Oil Company	Billings, Mont.	*Alkylation Plant	2,300 bbls.	.....	Under Constr.	2nd quarter 1959	UOP	Treco	Treco
		*Convert Bauxide Desulfurizing Unit to Hydrofiner.	10,000 bbls.	.....	Under Constr.	2nd quarter 1959	Esso	Treco	Treco
Cities Service	East Chicago, Indiana	Cat Reformer	7,500 bbls.	$4,000,000	Under Constr.	Late 1958	UOP	Staff Procon	Procon
Coastal Chemical Corp.	Pascagoula, Miss.	Ammonia	150 tons	$6,250,000	Under Constr.	Feb., 1960	.....	Chemico	Chemico
		*Super Phosphate Plant	480 tons	$300,000	Under Constr.	Dec., 1958	.....	Staff	Staff
Cooperative Farm Chemicals	Lawrence, Kansas	*Ammonia Urea	100 tons/30 tons	$4,400,000	Engineering	August, 1959	.....	Chemico	Chemico
Cooperative Refinery Assn.	Coffeyville, Kans.	HF Alkylation Unit	1,100 bbls.	$1,500,000	Complete	.....	UOP	Treco	Treco
Derby Refining	Wichita, Kansas	*TCC Unit & Gas Concentration Unit	.....	$800,000	Complete	.....	UOP	Litwin	Litwin
Dow Chemical	Bay City, Mich.	Petrochemical Plt.	.....	.....	Under Constr.	Summer 1959	.....	Bechtel	Austin
		Polyethylene Plt.	.....	.....	Under Constr.	Summer, 1959	Zeigler	Bechtel	Bechtel
du Pont	Ecorse, Mich.	Sulfuric Acid Plt.	.....	.....	Under Constr.	.....	.....	Bechtel	Bechtel
Ethyl Corp.	Joliet, Ill.	Antiknock Compounds	.....	.....	Planned	.....	.....	.....	.....
Goodyear Tire & Rubber	Point Pleasant, West Virginia	Polyester Resin	.....	$10,000,000	Planning	.....	.....	.....	.....
Grace Chemical Div. W. R. Grace & Co.	Memphis, Tenn.	Urea Expansion	200 tons	.....	Under Constr.	March, 1959	.....	Foster Wheeler	Process Contracting Co.
Grand River Chem.	Pryor, Okla.	Ammonia	10-15 tons	$200,000	.....	1958	.....	Treco	Treco
Gulf Oil	Toledo	Alkylation Unit	2,000 bbls.	.....	Under Constr.	Feb., 1959	.....	Kellogg	Kellogg
Leonard Refineries	Alma, Mich.	FCC Unit	7,500 bbls.	$3,000,000	Under Constr.	1958	UOP	Parsons	Parsons
		Alkylation Unit	1,000 bbls.	$1,100,000	Under Constr.	1958	UOP	Parsons	Parsons
Lion Oil, Div. of Monsanto	El Dorado, Ark.	Unifiner—Platformer	5,000 bbls.	$1,600,000	Engineering	Late 1958	UOP	UOP Procon	Procon
Monsanto Chemical	Monsanto, Ill.	Phenol Plt. Exp.	25 percent	.....	.....	.....	.....	.....	.....
	El Dorado, Ark.	Urea Plt.	.....	.....	Under Constr.	Late 1958	.....	Chemico	Chemico
Naph-Sol Refining	Muskegon, Mich.	*Exp. Crude Unit	10,000 bbls.	.....	.....	1958	.....	Litwin	Litwin
Nat'l Coop Refinery	McPherson, Kan.	Revamp crude, coking, and alkylation units offsite Facilities	.....	$1,800,000	Under Constr.	1958	UOP	.....	Treco
Northwestern Ref. Co.	St. Paul Park, Minn.	Cat. Reformer	6,000 bbls.	$2,500,000	Planning	Jan., 1959	.....	.....	.....
Ohio Oil	Robinson, Ill.	Revamp Houdriformer	.....	.....	Under Constr.	Fall, 1958	.....	.....	Catalytic
		*Heater Addition to Delayed Coker	1,400 bbls.	.....	Under Constr.	Nov., 1958	.....	Lummus	Catalytic
Olin Mathieson	Mapleton, Ill.	Antifreeze Plt.	.....	$1,500,000	Complete	.....	.....	.....	P. S. Edwards Company
Pana Refining	Pana, Ill.	Unifiner	1,870 bbls.	$1,000,000	Under Constr.	3rd Qtr., 1958	UOP	Procon	Procon
Pennsalt Chemicals	Wyandotte, Mich.	*Methylamines	.....	.....	Under Constr.	1958	.....	J.D. Leonard Assoc.	Catalytic
Phillips Petroleum	Kansas City, Kans.	Asphalt Exp.	1,100 bbls.	.....	Complete	.....	.....	Staff	.....
Reichhold Chemicals	Detroit	Formaldehyde Plt.	35,000, 000lbs./yr.	.....	Planning	.....	Staff	Staff	Staff
R & J Oil & Ref.	Princeton, Ind.	Unifiner	1,700 bbls.	.....	Planning	.....	.....	.....	.....
		Crude Unit	5,000 bbls.	.....	Under Constr.	Jan., 1959	.....	.....	.....
		Platformer	1,700 bbls.	.....	Planning	.....	.....	.....	.....
Shell Oil	Wood River, Ill.	Exp. Lube Oil Plt.	4,000 bbls.	.....	Engineering	Mid 1959	.....	Lummus	Lummus
		Offsite Facilities	.....	$10,000,000	Engineering	Mid 1960	.....	Parsons	Parsons
Signal Oil & Gas	Tioga, N. D.	Plt. Addition	.....	$235,000	Complete	.....	.....	Hudson	Hudson
		Tankage	.....	$200,000	Complete	.....	.....	Hammond Tank	Hammond Tank
	Healdton, Okla.	*Exp. Plant	.....	$315,000	Under Constr.	Dec., 1958	.....	Staff	Hudson
Sinclair Refining	East Chicago	MEK Deoiling	1,000 bbls.	.....	Under Constr.	Fall 1958	Texaco	Badger Mfg.	Badger Mfg.
Skelly Oil Co.	El Dorado, Kan.	HF Alkylation	3,000 to 4,000 bbls.	.....	Engineering	1958	Phillips	Staff	Staff
Socony Mobil	East St. Louis	Sovaformer	12,000 bbls.	.....	Planning	.....	.....	Fluor	Fluor
		Pretreater	16,000 bbls.	.....	Planning	.....	.....	Fluor	Fluor
Standard-Indiana	Whiting, Ind.	Crude Distillation	140,000 bbls.	.....	Under Constr.	1959	.....	.....	McKee
		*Vacuum Distillation Tower	36,000 bbls.	.....	Engineering	1959	.....	Braun	.....
		*Expand Cat Cracker	10,000 bbls.	.....	Engineering	1960	.....	Kellogg	.....
	Neodesha, Kans.	Ultraformer	6,000 bbls.	.....	Complete	.....	Std. (Ind.)	Foster Wheeler	Foster Wheeler
	Wood River, Ill.	Crude Unit	67,500 bbls.	.....	Under Constr	1959	.....	.....	McKee
		Cat Cracker	30,000 bbls.	.....	Under Constr.	Early 1959	.....	.....	McKee
		Vacuum Distill Tower	36,000 bbls.	.....	Engineering	1959	.....	.....	.....
	Mandan, N.D.	HF Alkylation Unit	1,630 bbls.	.....	Under Constr.	Late 1958	Phillips	Foster Wheeler	Foster Wheeler
Standard (Ohio)	Cleveland, Ohio	Alkylation	3,000 bbls.	$3,400,000	Complete	.....	Esso	McKee	McKee
Texas Company	Lawrenceville, Ill.	Cat. Reformer	12,000 bbls.	.....	Engineering	3rd Qtr., 1959	.....	Bechtel	Bechtel
		Hydrotreater	12,000 bbls.	.....	Engineering	3rd Qtr., 1959	.....	Bechtel	Bechtel
	Tulsa, Okla.	Alkylation	2,050 bbls.	.....	Engineering	3rd Qtr., 1959	.....	.....	.....
	Camrick, Okla.	*Gasoline Plant	.....	$1,500,000	Under Constr.	Nov., 1958	.....	Olsen	Olsen
Union Carbide	Marietta, Ohio	Liquid epoxy resin	15,000,000 lbs./yr	.....	Planning	.....	.....	.....	.....
Vickers Petroleum	Potwin, Kans.	Udex Unit	2,500 bbls.	$2,500,000	Complete	.....	UOP	Procon	Procon
Warren Petroleum & Sunray	Forgan, Okla	Gasoline Plt.	100 Mmscf	$3,000,000	Engineering	.....	.....	.....	.....
Witco Chemical	Chicago	Phthalic Anhydride	20,000,000 lbs./yr	.....	Engineering	Early 1959	Scientific Design	Scientific Design	Scientific Design
SOUTHWEST									
American Cyanamid	Fortier, La.	Acrylonitrile	100,000,000 lbs./yr.	$25,000,000	Under Constr.	1958	.....	Chemico	Chemico
American Oil	Texas City	Heating Oil System	.....	.....	Engineering	1958	.....	Tellepsen	Tellepsen
		Two Stage Distill Unit	.....	.....	Under Constr.	1958	.....	Staff	Tellepsen
American Petrofina of Texas	Mt. Pleasant, Texas	Platformer	3,000 bbls.	$800,000	Under Constr.	Nov., 1958	UOP	Pritchard	Pritchard
		Alkylation Plant	1,400 bbls.	$1,000,000	Under Constr.	Nov., 1958	UOP	Pritchard	Pritchard
Atlas Processing	Shreveport, La.	Isomerization Unit	3,500 bbls.	.....	Complete	.....	UOP	UOP	Hudson
Calcasieu Chemical	Lake Charles	Ethylene Oxide; Ethylene Glycol	8,000,000 gal./yr.	.....	.....	1958	Shell	.....	Lummus
Carbide & Carbon	Seadrift, Texas	Ethylene Oxide Exp.	To 200,000,000 lbs./yr.	.....	Planning	.....	.....	.....	.....
		Inc. Ethylene Glycol Cap.	To 65,000,000 lbs./yr.	.....	Planning	.....	.....	.....	.....
Chemoil Corp.	New Orleans	Refinery	40,000 bbls.	$35,000,000	Design	.....	.....	Lummus	Lummus
	Baton Rouge	*Refinery	40,000 bbls.	$35,000,000	.....	.....	.....	.....	.....
Cities Service	Lake Charles, La.	Inc Reforming Cap.	.....	.....	Planning	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 176

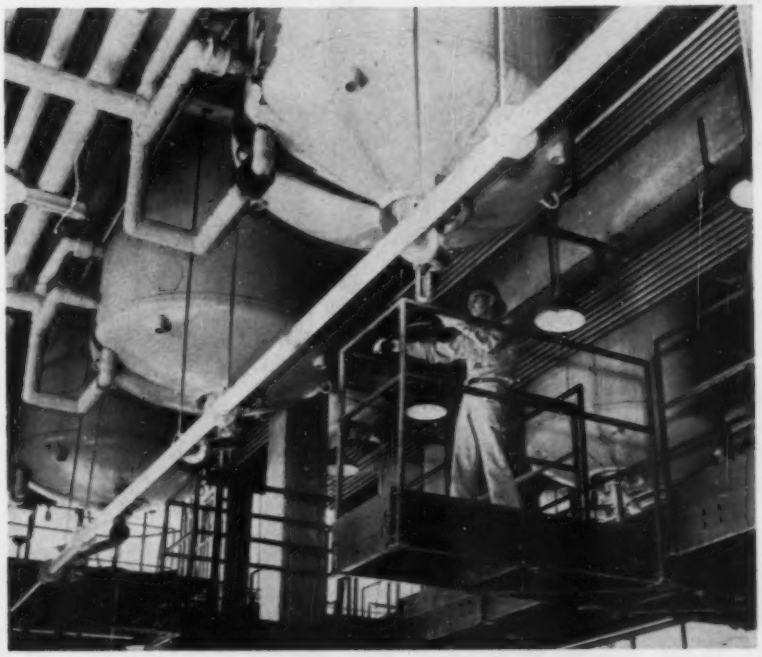
CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Copolymer Rubber & Chemical	Baton Rouge	Plt. Exp. Butadiene	35,000 short tons yr.	.....	Under Constr.	4th Qtr., 1958	.....	.....	.....
Diamond Alkali.....	Houston	Perchlorethylene Exp.	50 percent	.....	Under Constr.	.....	.....	.....	.....
		Acetylene Plt.	.....	.....	Engineering	.....	.....	.....	.....
	Deer Park	Vinyl Chloride Plt.	.....	$10,000,000	Engineering	1958	.....	Scientific Design	Brown & Root
		Copolymer Unit	25,000,000 lb/yr	.....	Under Constr.	1958	.....	Ferguson, Staff	Brown & Root
Dow Chemical.....	Plaquemine, La.	Ethylene and Propylene Glycols and Oxides, Chlorinated Solvents	.....	$65,000,000	Under Constr.	1958	.....	Bechtel; Sterns-Roger	Sterns-Roger; Tellepsen
	Freeport, Texas	Acetylene, Methylacetylene, Chlorine, Ethylene Oxide	.....	$30,000,000	Under Constr.	1959-60	.....	.....	.....
		*Acrylonitrile							
		*Polyethylene							
		*Polyglycol	.....	$30,000,000	1959-60	.....	.....	.....	.....
du Pont.....	Orange	Polyethylene	.....	.....	Under Constr.	1958	.....	.....	.....
	Near New Orleans	Petrochemical Plt.	.....	.....	Considering	.....	.....	.....	.....
El Paso Natural Gas Products	Odessa, Texas	Alkylation Blending	.....	.....	Under Constr.	.....	.....	.....	.....
		Dehydration Plant	.....	.....	Under Constr.	.....	.....	Braun	Braun
	Crane, Texas	*Expansion of Compressor and Treating Plant	.....	$2,000,000	Under Constr.	Dec., 1958	.....	Olsen	Olsen
Esso Standard.....	Baton Rouge	Sulfuric Acid Alkylation	10,000 bbls.	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Goodrich-Gulf Chemicals	Port Neches, Texas	Exp. Synthetic Rubber Plant	.....	$1,000,000	Under Constr.	Dec., 1958	.....	Catalytic	Catalytic
Gulf Oil.....	Pt. Arthur, Texas	Greasemaking; Packaging	.....	.....	Under Constr.	1958	.....	Sumner Sollitt	Sumner Sollitt
		Platformer	26,000 bbls.	.....	Complete	.....	UOP	Procon	Procon
		Gasoline Processing	10,000 bbls.	$4,000,000	Under Constr.	Late, 1958	UOP	Procon	Procon
		Benzene Plt.	82,000 gals	$6,800,000	Under Constr.	Early 1959	UOP	Procon	Procon
Humble.....	Baytown, Texas	Phenol Lube Plt. No. 2	31,500 bbls.	.....	Engineering	1958	.....	Kellogg	Brown & Root
	Rusk County, Texas	*Remote Absorber	80 Mmcf	.....	Engineering	Late 1958	.....	Staff	.....
	Kleberg, County, Texas	Gas Process & Cycling Plt.	800 Mmcf	$77,000,000 Project	Planning	1960	.....	Staff	.....
	Fluor Bluff, Tex.	Exp. Gasoline Plt.	35 Mmcf	$4,000,000	Complete	.....	.....	Staff	Olsen
Jefferson Chemical....	Port Neches, Texas	Inc. Ethylene Cap.	.....	.....	Under Constr.	Late 1958	S&W	S&W	S&W
		Inc. Ethylene Glycol Cap.	.....	.....	Under Constr.	Fall 1958	.....	Braun	Braun
		Inc. of Ethylene Oxide Cap.	.....	.....	Under Constr.	.....	Scientific Design	Scientific Design	Scientific Design
Koppers Co.....	Port Arthur, Tex.	*Exp. Polyethylene Plant	.....	.....	.....	.....	Staff	Staff	Staff
La Gloria Oil & Gas..	Tyler, Texas	Gas Concentration; Revamp Cat Cracker	.....	.....	Under Constr.	4th Qtr., 1958	UOP	UOP	Brown & Root
Magnolia.....	Beaumont, Texas	Crude Distill.	100,000 bbls.	.....	Under Constr.	Late 1958	.....	Foster Wheeler	Foster Wheeler
		Sovafiner	30,000 bbls.	.....	Under Constr.	Late, 1958	Socony Mobil	Staff, Foster Wheeler	Foster Wheeler
		Exp. LPG Fractionation	.....	.....	Complete	.....	.....	Magnolia, Fluor	Fluor
	Cameron Meadows, La.	Gas Processing Plant	150 Mmcf	.....	.....	April, 1959	.....	.....	.....
McBride Refining Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	$2,500,000	Planned	.....	.....	.....	.....
Monsanto.....	Texas City	Exp. Acrylonitrile Plt.	100,000,000 lbs./yr.	.....	Under Constr.	1958	.....	.....	.....
		Inc. Styrene Monomer Cap.	†40,000,000 lbs./yr.	.....	.....	1958	.....	.....	.....
Neches Butane Products	Port Neches, Texas	Butadiene Plt. Exp.	300,000 tons/yr.	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Pan American Petroleum	18 miles north of Monahans, Tex.	Gas Processing Plant	4 Mmcf	.....	Under Constr.	Nov., 1958	.....	.....	.....
Petroleum Chemicals.	Lake Charles	Butyl Rubber Plt.	30,000 tons/yr.	$17,000,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Petro-Tex.....	Houston	Sulfuric Acid Alkylation Plt.	3,000 bbls.	.....	Under Constr.	Late 1958	Texaco	Fluor	Fluor
		Isobutylene Unit	2,000,000 gal/yr.	$250.000	Under Constr.	Dec., 1958	.....	.....	.....
Phillips Chemical.....	Sweeny, Texas	Ethylene Plant†	.....	.....	Under Constr.	Spring, 1959	.....	Phillips	Phillips
Phillips Petroleum....	Sweeny, Texas	Hexane Isomerization	1,000 bbls.	.....	Under Constr.	1959	.....	Phillips	Phillips
Pontiac Refining.....	Corpus Christi	Crude Revamp	.....	.....	Complete	.....	.....	Fluor	Fluor
Shell Chemical.....	Norco	Cat. Gasoline Fractionator	.....	.....	.....	.....	Monsanto	Leonard Constr. Co.	Leonard Constr. Co.
		Platformer	16,000 bbls.	.....	Under Constr.	1958	.....	Procon	Procon
		Acrolein Plant	35,000,000 lbs./yr.	.....	Under Constr.	.....	.....	.....	.....
		Glycerine & Offsite Fac.	35,000,000 lb/yr	$4,500,000	Engineering	1959	.....	Staff	Parsons; Fluor
	Houston	*Phenol Plant	.....	.....	.....	Late 1959	.....	.....	Kellogg
Sinclair Refining.....	Houston	Udex Paraxylene	50,000,000 lbs./yr.	$6,000,000	Under Constr.	Late 1958	UOP	Badger Mfg.	Badger Mfg.
		Steam Generating & Water Treating	250,000 lbs. hr.	$1,500,000	Under Constr.	Late 1958	.....	Kidde Engrs.	Kidde Const.
	Hulldale Field, Texas	Desulfuriser	.....	.....	Under Constr.	.....	.....	.....	.....
Spencer Chemical....	Orange, Texas	Polyethylene Exp.	90,000,000 lbs./yr.	.....	Under Constr.	.....	.....	Staff	Quaker Valley
Suntide Refining.....	Corpus Christi	Gas Recovery Unit	2,000 bbls.	$275,000	Complete	.....	UOP	Staff	Staff
		*Orthyo-xylene Fractionation Unit	1,000 bbls.	$550,000	Complete	.....	UOP	Staff	Staff
Texas Eastman.....	Longview, Tex.	Exp Polyethylene Plant	85,000,000 lbs./yr.	.....	Under Constr.	1958	.....	Girdler	Girdler & Hudson
Texas Natural Gasoline Corp. & Tennessee Gas Transmission	New Orleans	Natural Gasoline Plant	150 Mmcfd	.....	Under Constr.	Nov., 1958	.....	.....	.....
The Texas Co.....	Port Arthur	Crude Unit	86,000 bbls.	.....	Under Constr.	3rd Qtr., 1958	.....	Fluor	Fluor
		Cat. Cracker	60,000 bbls.	.....	Under Constr.	3rd Qtr., 1958	.....	Kellogg	Kellogg
		Inc. Alkylation	2,000 bbls.†	.....	Under Constr.	3rd Qtr., 1958	.....	Staff	Staff & Others
		Cat. Reformer	20,000 bbls.	.....	Engineering	2nd Qtr., 1959	.....	UOP	Staff & Fluor
		Udex Unit	28,000 bbls.	.....	Engineering	2nd Qtr., 1959	.....	UOP	Staff & Fluor
	El Paso	Alkylation	1,600 bbls.	.....	Engineering	3rd Qtr., 1959	.....	Texas Co.	
Transcontinental Gas Pipeline	Tilden, Texas	*Gas Treating & Dehyd. Plant	.....	.....	Complete	.....	.....	Fluor	Fluor
United Rubber & Chemical	Baytown, Texas	Synthetic Rubber Facil.	.....	.....	Under Constr.	1958	.....	Day & Zimmerman	Tellepsen

* First appearance in tabulation. † Added capacity.

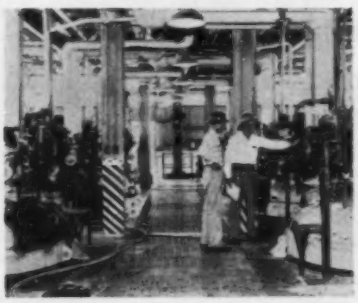
Construction BOXSCORE Continued on Page 179

PFAUDLER CORROSIONEERING NEWS



How Diamond Alkali uses Glasteel to cut turn-around time and protect purity at its PVC plant

Like most polymers, polyvinyl chloride gets so sticky in process that it gums up equipment surfaces to the point that a general clean-out is usually required after each batch.



Wishing to avoid such unproductive, unprofitable time at its new Deer Park, Texas plant, the Diamond Alkali Company instructed its engineers to run comparative tests on materials of construction.

Pfaudler Glasteel was the final choice and Diamond Alkali uses it wherever possible in the new plant . . . for polymerizers, blow-down tanks, storage and receiver tanks, and even for pipes and valves.

So little of the PVC clings to the smooth glassed surfaces of this equipment, a simple fast flush is all that's necessary to keep it in process condition.

During two years of operation, on a twenty-four hour a day basis, production has been halted only for routine maintenance.

Protects purity too

Pfaudler Glasteel is chemically inert to the ingredients and catalysts used in making PVC . . . so there can never be any contamination of Diamond Alkali's product.

Special agitator seals on the polymerizers prevent any lubricants from bleeding into the product.

The equipment is so designed and controlled that Diamond Alkali can hold temperatures to within ½° F. of a desired setting.

If you would like to know more about Pfaudler Glasteel and the equipment made with it, check the coupon for our Bulletins 968 and 932.

Big zirconium and titanium heat exchangers now available

Recent addition of vacuum-purge inert gas welding to the already established flow-purge inert gas welding chamber shown below, places Pfaudler in the advantageous position of offering the most advanced facilities for welding the highly corrosion-resistant metals, titanium and zirconium. Now several hundred square feet of heat transfer surface can be more economically and rapidly produced.

Add these metals to your list of available Pfaudler materials for fighting corrosion in process equipment—an ever growing list that already includes Glasteel, stainless steel, Hastelloy, nickel, Inconel, and Monel.

The unit being worked on in the picture is one of the largest zirconium exchangers built to date, having 134 square feet of heat transfer area. Sixty-four 1" O.D. 18 gauge seamless zirconium tubes in a 21" O.D. shell 8' long. Designed for 75 psi and 350° F. it forms the calandria section of an evaporator for concentrating hydrogen peroxide solutions.

Pfaudler Bulletin No. 949 describes the complete line of metal and alloy heat exchangers. Heat transfer equipment of Glasteel construction are covered in Bulletins No. 921 and No. 886. Send the coupon for copies.

PROCESS EQUIPMENT by PFAUDLER
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Dept. PR-108, Rochester 3, N. Y.

Please send me ☐ Bul. 968 and 932, Buyer's Guide; ☐ Bul. 949, Heat Exchangers; ☐ Bul. 921 and 886 on Glasteel Heat Transfer Equipment.

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City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

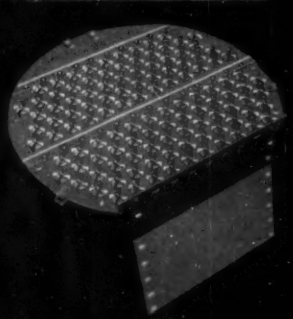
KOCH FLEXITRAYS

add higher capacities and efficiencies to Cities Service giant fractionating tower

This huge splitter, 13′ 6″ I. D. x 208′ 6″ overall length, erected in the Cities Service Refinery in Lake Charles, La., is believed to be the largest pressure vessel ever erected in one piece.

Koch Flexitrays make it tick. Flexitrays often save refineries and chemical plants 20% - 40% on total cost of complete tower installations.

On your next tower be sure to investigate Koch Flexitrays. The marked success of this low-priced tray has resulted in its use in more than 800 non-captive installations.



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CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
U. S. I. Chem. Corp.	Houston	Polyethylene Plant	75,000,000 lbs./yr.	$20,000,000	Under Constr.	Early 1959	I.C.I.	Kellogg	Kellogg; Tellepsen
ROCKY MOUNTAIN									
Carter Oil Co.	Billings, Mont.	Increase Crude Cap.	24,500 bbls.	$1,500,000	Under Constr.	1958	.....	Esso	Staff
Pan American	Riverton, Wyoming	*Gasoline Plant	.....	$1,000,000	Under Constr.	.....	.....	Olsen	Olsen
Southwestern Agro-chemical Corp.	Chandler, Ariz.	Ammonia Synthesis Plt. and relate facilities	90 tons	$5,000,000	Planning	June, 1959	.....	.....	.....
The Texas Co.	San Juan County, Utah	Gasoline Plt.	.....	.....	.....	.....	.....	.....	.....
WEST COAST									
Alaska-Yukon Refiners	Haines, Alaska	Refinery	7,500 bbls.	$6,000,000	Engineering	1958	.....	Treco	Treco
California Ammonia Co.	Lathrop, Calif.	Ammonia Synthesis Plt	100 tons	$5,000,000	Engineering	1959	.....	Macco	Macco
Caminol Co.	Hanford, Calif.	*Platforming Unit & Offsite Facilities	1,300 bbls.	$650,000	Complete	.....	UOP	Litwin	Litwin
du Pont	Antioch, Calif.	Fluorinated Hydrocarbons, Tetraethyl Lead	.....	.....	Under Constr.	.....	.....	.....	.....
Fletcher Oil	Wilmington, California	Unifiner Platformer	.....	.....	Under Constr.	1958	UOP	Parsons	Parsons
Hancock Oil	Long Beach, Calif.	Rebuild Refinery	.....	.....	Engineering & Under Constr.	1959	.....	Parsons	Parsons
Hercules Powder	Hercules, Calif.	Urea Plt.	60 tons	.....	Complete	.....	Vulcan-Inventa	Vulcan	Vulcan
		*Pilot Plant Nitrogen Tetroxide	.....	.....	.....	.....	.....	.....	.....
Richfield Oil	Los Angeles	Benzene Plt.	18,000,000 gal./yr.	.....	Under Constr.	1958	.....	.....	.....
	Watson, Calif.	Crude Topping Unit	37,000 bbls.	$4,000,000	Under Constr.	1st Qtr. 1959	.....	Parsons; Staff	Parsons
Shell Chemical	Dominguez, Calif.	Exp. Isopropyl Alcohol Facl.	.....	.....	Under Constr.	Fall 1958	.....	.....	.....
Shell Development Co.	Emeryville Calif.	Research Lab.	.....	$500,000	Under Constr.	.....	.....	.....	.....
Shell Oil	Wilmington	Boiler for Cat. Cracker	200,000 lbs.	$1,000,000	Under Constr.	.....	.....	.....	.....
Standard Oil (Calif.)	Richmond	Cat. Reformer	20,000 bbls.	$11,000,000	Complete	.....	.....	Staff-Bechtel	Bechtel
		Paraxylene Plt.	.....	.....	Complete	.....	.....	Staff-Bechtel	Resendahl Corp.
		FCC Unit	40,000 bbls.	.....	Under Constr.	July, 1959	.....	Fluor	Fluor
	El Segundo	Deisobutaniser	†300 bbls.	$1,500,000	Complete	.....	.....	Staff	Macco
		Steam Generating Plant	275,000 lbs./hr.	$2,000,000	Engineering	July, 1959	.....	Fluor	Fluor
The Texas Co.	Anacortes, Wash.	*Refinery *Fluid Cat Cracker *Alkylation *Reforming *Polymerization *Hydrotreating	40,000 bbls.	.....	Under Constr.	1st Qtr, 1959	.....	Bechtel	Bechtel
	Los Angeles	Udex Unit	9,000 bbls.	.....	Under Constr.	2nd Qtr. 1959	.....	UOP	
Tidewater	Avon, Calif.	Steam Generating Plt.	50,000 lbs./hr.	.....	Under Constr.	3rd Qtr., 1958	.....	Bechtel	Bechtel
OUTSIDE U.S.A.									
Hawaii									
Standard Oil (Calif.)	Honolulu	Refinery	35,000 bbls.	$40,000,000	Engineering	1961	.....	Staff, Bechtel	Bechtel, Hawaiian Dredging
Canada									
British American Oil	Clarkson, Ont.	Distillate Desulfuriser	8,000 bbls.	$4,000,000	Planning	Mid-1960	.....	Nofsinger	.....
	Nevis, Alberta	Gasoline Plt.	30,000 gals.	.....	.....	.....	.....	.....	.....
	Pincher Creek	Sulfur Recovery	225 tons	.....	Under Constr.	.....	.....	Parsons	Parsons
		Gas Processing	2,200 bbls.	.....	.....	.....	.....	.....	.....
	Port Moody	Refinery	20,000 bbls.	$25,000,000	Under Constr.	Late 1958	.....	Kellogg	Kellogg
	Moose Jaw, Sask.	Cat Reformer & HDS Unit	5,400 bbls.	$4,000,000	Under Constr.	Late 1958	Atlantic	Lummus	Lummus
		Gas Splitter	.....	.....	Engineering	Fall 1958	UOP	UOP Procon	Procon
			7,000 bbls.	$4,000,000	Under Constr.	Late 1958	.....	Procon	Procon
	Montreal	Gaso. Splitter	12,000 bbls.	$750,000	Under Constr.	Late 1958	.....	Procon	Procon
British Petroleum	Ville D'Anjou Near Montreal	Refinery	30,000 bbls.	$30,000,000	Under Constr.	.....	.....	.....	Lummus
Canadian Husky Oil	Ft. William	Diesulfomer & Tankage	1,000 bbls.	$700,000	Under Constr.	.....	Husky	.....	Poole-Pritchard
Canadian Oil Co., Ltd.	Corunna, Ontario	Platformer Exp.	6,000 bbls.	.....	Under Constr.	1958	UOP	UOP	CATALYTIC
		Crude Unit	20,000 bbls.	$3,000,000	Engineering	1959	.....	Kellogg	Kellogg
Canadian Petrofina	Montreal	Increase Cap.	30,000 bbls.	$3,000,000	Under Constr.	1958	.....	Staff	Procon (Canada)
Cities Service	Toronto	New Refinery	20,000 bbls.	$26,000,000	Under Constr.	Dec., 1958	.....	Braun, Ltd.	Braun, Ltd.
Consumers, Cooperative Refinery, Ltd.	Regina, Sask.	Coking Unit	3,000 bbls.	$1,500,000	Under Constr.	Late 1958	.....	UOP; Staff	Fluor; Staff
Canadian Industries, Ltd.	Edmonton, Alberta	Inc. Polythene	40,000,000 lbs./yr.	.....	Under Constr.	1959	.....	.....	Poole Constr. Co., Ltd.
Cyanamid of Canada	Hamilton, Ontario	Urea; Ammonia	.....	.....	Engineering	1959	.....	Chemico	Chemico
Devon-Palmer & Texas Gulf Sulfur	Calgary, Alberta	Sulfur Extraction Plant	400 tons	$8,000,000	Planning	Mid 1959	.....	.....	.....
Ezcelsior Refineries	The Pas, Manitoba	Refinery	2-3,000 bbls.	$1,800,000	Planning	.....	.....	.....	.....
Imperial Oil	Sarnia	Petrochemical Plt.	.....	$25,500,000	Complete	.....	.....	Canadian Bechtel	Canadian Bechtel
		Refinery Exp.	94,000 bbls.	$5,360,000	Under Constr.	Summer, 1959	.....	Staff	Staff
	Edmonton, Alberta	Asphalt Plant & Storage	1,500 bbls.	$1,400,000	Under Constr.	Spring, 1959	.....	Staff	.....
	Calgary	Crude Cap.	14,700 bbls.						
		Cat. Cracker	6,600 bbls.	$17,000,000	Under Constr.	Late 1959	.....	Canadian Bechtel; Staff	Canadian Bechtel
		Powerformer	2,700 bbls.						
		Offsite Facilities							
	Regina	Powerformer	3,000 bbls.	$2,500,000	Planning	September, 1959	.....	Staff	Canadian Kellogg
Irving Refining	St. John, New Brunswick	Hydrogen Plant	.....	$45,000,000	Engineering	1960	.....	Girdler Bechtel	Canadian Bechtel
North Star Oil, Ltd.	St. Boniface, Manitoba	Platformer Unifiner	2,700 bbls.	$1,100,000	Engineering	Late 1958	UOP	UOP Procon	Procon
Pacific Petroleum, Ltd.	Dawson Creek	Vacuum Distill. Unit	.....	$350,000	Complete	.....	.....	Pacific, Phillips	Pacific
		Inc. Crude Cap.	2,500 bbls.	.....	Complete	.....	.....	Pacific Petroleums; Phillips	Pacific Petroleums
Shell Oil (Canada)	Bronte, Ont.	Refinery	.....	.....	Considering	.....	.....	.....	.....
	Montreal	HF Alkylation	1,500 bbls.	$4,000,000	Under Constr.	1959	UOP	UOP Treco, Staff	Treco
	Montreal, East	Exp. Asphalt Plt.	.....	$450,000	Complete	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 180

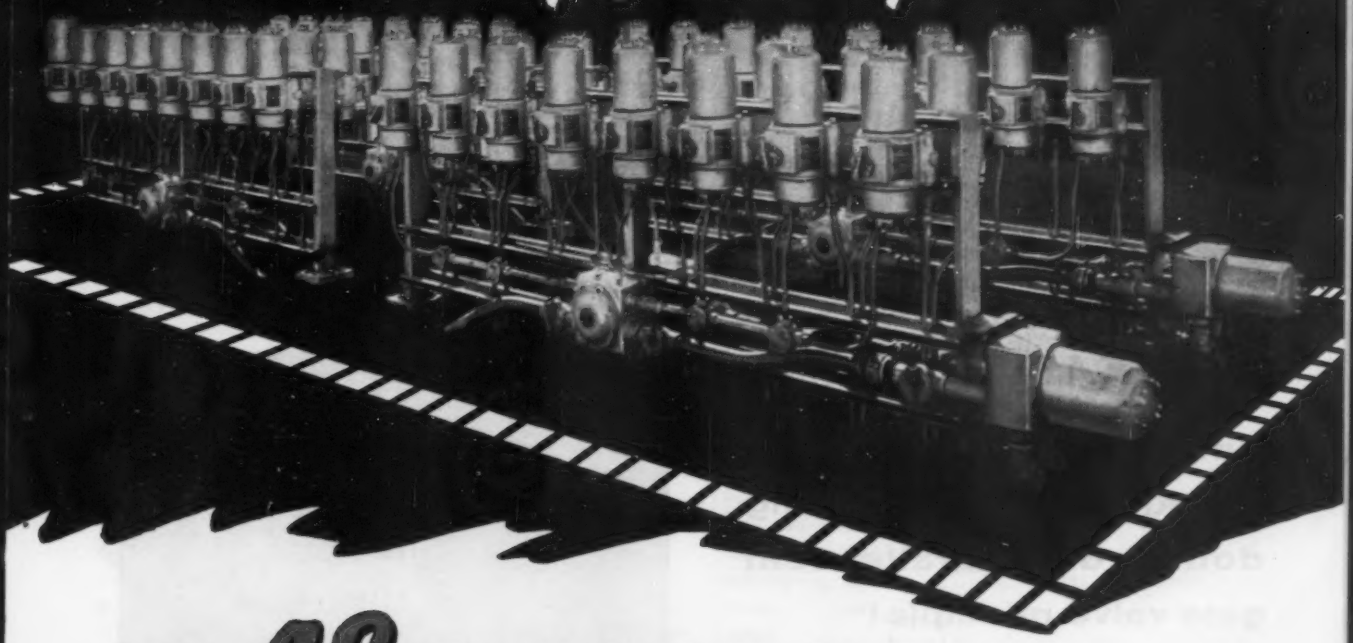
CONSTRUCTION BOXSCORE—*Continued*

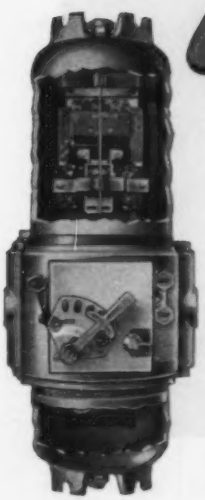
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Oil (Canada).... (Cont.)	Quebec	Tetramer Unit	.....	.....	Complete	.....	.....	Treco, Staff	Treco
		Resin Plt.	.....	$1,000,000	Complete	.....	.....	Treco, Staff	Treco
	Cochrane, Alberta	Exp. Treating Plt.	.....	.....	Complete	.....	.....	.....	.....
	Vancouver	Solvent Plt.	.....	$600,000	Under Constr.	1958	.....	Fluor, Staff	Staff
Steelman Gas, Ltd....	Southeast Saskatchewan	Natural Gas Plant	25 Mmcf	$6,500,000	Under Constr.	1958	.....	Stearns-Roger, Engineering Co. Ltd.	Treco, Ltd.
Wainwright Prod. & Refiners, Ltd.	Wainwright, Alberta	Visbreaking Unit	.....	.....	Complete	.....	.....	Litwin	Sioux
LATIN AMERICA									
Brazil									
Alba (Borden).....	**Cubatao**	**Methanol, Formaldehyde, Synthetic Resins**	**30 tons**	**$4,600,000**	**Under Constr.**	**Dec., 1958**	**Vulcan Texaco Fischer**	**Vulcan Girdler**	**Staff Girdler Austin; Montreal, S.A.**
Anglo-Ecuadorian Oilfields, Ltd.	La Libertad Ecuador	*Atmospheric Distillation Plant	7,000 bbls.	$4,500,000	Under Constr.	.....	UOP	Procon	Procon
Empresa Colombiana de Petroleos	El Centro	*Nat. Gasoline Plant	51.4 Mmcf	$2,700,000	Under Constr.	October, 1959	.....	Parsons	Parsons
North American Solvay, Inc.	Sao Paulo	*Ethylene Purification	20 tons	.....	Under Constr.	1st quarter 1959	.....	Hydrocarbon	Hydrocarbon/ SETAL
Petroleo Brasileiro....	**Mataripe**	**Atmospheric & Vacuum Distill. Units, Cat. Crkr., Gas Recovery, Wax Treating, Lube Plt.**	**37,000 bbls.**	.....	**Under Constr.**	**1960**	**Kellogg**	**Kellogg**	**Kellogg Brasileira; Montreal, S. A.**
	Rio de Janeiro	**New Refinery**	**90,000 bbls.**	**$60,000,000**	**Engineering**	**Early 1960**	.....	**Foster Wheeler**	.....
	Cubato	*Ethylene Recovery	40,000,000 lbs/yr	.....	Complete	.....	.....	Hydrocarbon/ Hydro M	Staff
	South Brazil	Refinery	70,000 bbls.	.....	Planning	.....	.....	.....	.....
Uhde.....	**Cubatao**	**Urea Plt.**	.....	.....	.....	.....	.....	**Uhde**	**Uhde**
Union Carbide.....	**Cubatao**	**Polyethylene**	.....	.....	**Under Constr.**	**1958**	.....	**Brown & Root**	**Brown & Root Ltd.**
Colombia									
Empresso Colombiana de Petroleos	**Barranca Bermeja**	**Exp. Propane Recovery**	**1,000 bbls.**	**$1,000,000**	**Planning**	.....	.....	.....	.....
Chile									
Empresa Nacional del Petroleo	**Concon**	**Refinery Exp:**							
		Crude Topping	**24,000 bbls.**						
		Vacuum Unit	**10,000 bbls.**						
		Orthoflow FCC Unit	**12,000 bbls.**	**$15,000,000**	**Under Constr.**	**Oct., 1959**	**Kellogg**	**Kellogg**	**Staff & Kellogg**
		SBK Cat. Reforming and Desulfurization	**6,000 bbls.**						
		Alkylation Unit	**1,100 bbls.**						
Ecuador									
Anglo-Ecuadorian Oilfields, Ltd.....	**Santa Elena Ancon**	**Atmospheric Distillation**	.....	.....	**Under Constr.**	**1958**	**UOP**	**Procon**	**Procon**
		Thermal Cracking Units	.....	.....	**Under Constr.**	**1958**	**UOP**	**Procon**	**Procon**
Mexico									
Pemex.....	**Ciudad Madero**	**Topping**	**100,000 bbls.**						
		Cat. Cracking	**25,000 bbls.**						
		Gas Concentration; HF Alkylation; Polymerization; Sulfur Plt.		**$25,700,000**	**Under Constr.**	**1958**	**Phillips, Esso, UOP**	**McKee**	**Staff**
	Salamanca	**Grease Plt.**	**25 tons**	**$1,700,000**	**Engineering**	.....	.....	**McKee**	**Staff**
		Cat. Cracker	**15,000 bbls.**	.....	**Planning**	.....	.....	.....	.....
	Poza Rica	**Topping Plt.**	**10,000 bbls.**	**$1,350,000**	**Engineering**	.....	.....	**Staff**	**Staff**
Netherlands Antilles									
Largo Oil & Transport	**Aruba, N. A.**	**Revamp Distillation & Visbreaking Units**	.....	.....	**Engineering**	**Nov., 1959**	.....	**Kellogg**	**Kellogg**
Panama									
Refinor a Petroquimica de Panama	Portobelo	Refinery	60,000 bbls.	$40,000,000	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Refineria Panama....	**Las Minas Bay, Coson**	**Refinery; Petrochemicals**	**70,000 bbls.**	**$50,000,000**	**Under Constr.**	**1959**	.....	**Pet. Comb. & Eng. Co.**	**Pet. Comb. & Eng. Co.**
Paraguay									
Compagnie Fives-Lille	**Asuncion, Paraguay**	**Refinery**	**10,000 bbls.**	.....	**Planning**	.....	.....	.....	.....
Puerto Rico									
Commonwealth Oil Refining	**Guayanilla Bay**	**Refinery Exp.**	**75,000 bbls.**	**$9,500,000**	Under Constr.	**1959**	.....	UOP; Lummus	Lummus & others
Union Carbide Caribe	**Ponce**	**Ethylene-Glycol**	**500,000 lbs.**	**$23,500,000**	**Planning**	**Early 1959**	.....	**Brown & Root**	**Brown & Root**
Trinidad									
Federation Chemicals, Ltd.	Point Lisas	Nitrogen Plant	100 tons	$12,000,000	Under Constr.	Fall, 1959	Kellogg	Braun & Kellogg	Braun
		*Urea	70 tons	.....	.....	.....	Monsanto,	.....	.....
		*Ammonia	100 tons	.....	.....	.....	Stamicarbon	.....	.....
		*Sulfuric Acid	200 tons	.....	.....	.....	.....	.....	.....
		*Ammonium Sulfate	245 tons	.....	Under Constr.	1959	.....	Braun-Kellogg	Braun-Kellogg
Texaco Trinidad, Inc..	Pointe-a-Pierre Trinidad	*Rexformer	8,000 bbls.	$7,000,000	Complete	.....	UOP	PROCON	PROCON
Trinidad Oil Co., Ltd.	**Pointe a-Prierre**	**Processing Units**	.....	.....	**Under Constr.**	**1958**	**UOP**	**Procon**	**Procon**
Uruguay									
Administracion Nacional de Combustibles Alcohol Y Portland	Montevideo	Crude Distill.	28,000 bbls.	$12,000,000	Engineering	Late 1959	.....		
		Vac. Distill.	10,000 bbls.	.....	.....	.....	.....		
		Cat. Cracker	5,000 bbls.	.....	.....	.....	.....		
		Cat. Reformer	3,000 bbls.	.....	.....	.....	.....		
		Gas Concent. & Bottling	.....	.....	.....	.....	.....	Kellog	Staff
		Gas Sweetening	4,500 bbls.	.....	.....	.....	.....		
		Sulfur Recovery	6 tons	.....	.....	.....	.....		
		Power Plt. & Offsite Facil.	3,600 KW	.....	.....	.....	.....		
Venezuela									
Cia Shell de Venezuela	Cardon	Distillation	80,000 bbls.	$20,000,000	Under Constr.	3rd Qtr., 1958	.....	.....	.....
		Alkylation	2,800 bbls.	.....	Under Constr.	3rd Qtr., 1958	.....	.....	.....
Creole Pet. Corp.....	Amuay Bay	Naphtha Fractionator	45,000 bbls.	.....	Engineering	1959	.....	Esso	.....
Socony Mobil.....	El Palito	Refinery	40,000 bbls.	$28,000,000	Under Constr.	Late 1959	.....	Kellogg	Kellogg
Venesuela Gulf Refg.	Puerto la Cruz	*Crude Distillation	65,000 bbls.	.....	Engineering & Constr.	Late 1959	.....	Foster Wheeler	Foster Wheeler
EUROPE AND AFRICA									
Austria									
Austrian Oil Administration	Schwechat near Vienna	Crude Unit, Cat Reformer Gas Recovery & Chemical Units	35,000 bbls. 7,000 bbls.	$22,300,000	Engineering	End 1959	.....	Lurgi	Lurgi

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 183

CROUSE-HINDS
Condulet* motor controls
Occupy Less Space!





48 Explosion-Proof Combination Motor Starters and Circuit Breakers . . . *in a 25 ft. x 6 ft. Area!*

Crouse-Hinds Condulet* Type EPC Motor Starters and Circuit Breakers are explosion-proof, dust-tight (dust-ignition-proof) and weather-resistant (raintight).

Lightweight cast aluminum construction for easy installation without use of lifting equipment.

Seven Conduit entrances simplify installation.

Built-in push button stations and selector switches are available.

Starter sizes 0 to 5. Circuit breakers 50 to 600-amp. frame sizes.

In the installation shown above, 48 Crouse-Hinds Condulet* Type EPC combination motor starters and circuit breakers are compactly arranged in four racks.

If necessary, the 25 ft. x 6 ft. area used could have been cut in half by installing the Condulet motor controls in two tiers. Or, *twice* as many Condulet controls could have been installed in the same area, if required.

The *vertical design* of Crouse-Hinds motor starters, circuit breakers and combinations allows them to be installed only ¼" apart. This compactness produces savings in the construction of steel mounting racks, and in the use of premium floor space.

● **For help in solving a space problem, see your Crouse-Hinds distributor . . . or call the nearest Office listed below**

*Registered

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.

Offices: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, St. Louis, St. Paul, San Francisco, Seattle, Tulsa, Washington, Wilkes-Barre, Worcester, Youngstown. Canadian Plant and Offices: Crouse-Hinds Company of Canada Ltd., Toronto, Ont.

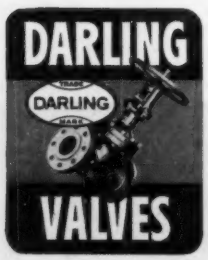
ALUMINUM GATE VALVES

BY DARLING

FEATURING:

unmatched advantages of DARLING fully revolving double disc parallel seat gate valve principle!

There's new economy to be gained in the handling of "problem" fluids and gases with Darling aluminum alloy gate valves . . . now available in ½″ through 24″ sizes. We have data on initial and long-range costs and performance that will interest you. Write for facts.



DARLING VALVE & MANUFACTURING CO.

Williamsport 31, Pa.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Belgium									
Esso Belgium	Antwerp	Vac. Distill.	2,900 bbls.	$750,000	Complete	.....	.....	Badger-Comprimo	Badger-Comprimo
		Powerformer	5,600 bbls.	$7,100,000	Complete	.....	Esso	Badger-Comprimo	Badger-Comprimo
		Hydrofiner	6,900 bbls.						
Soc. Industrielle Belge des Petroles	Antwerp	Cat. Reformer	10,000 bbls.	.....	Complete	.....	UOP	Kellogg; UOP	Kellogg
		Hydrofiner	10,000 bbls.	.....	Complete	.....	.....	Kellogg	Kellogg
Canary Islands									
Copsa	Las Palmas	Ammonia	90 tons	.....	Engineering	Late 1958	Hoechst	Uhde	Uhde
Denmark									
The Maersk Refinery	Copenhagen	Steam Cracker	3,500 bbls.	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Egypt									
Anglo-Egyptian Oilfields	Suez	Cat. Reformer	2,200 bbls.	.....	Projected	.....	.....	.....	.....
Egyptian Govt.	Suez	Power Plt.	10,000 KW.	$2,200,000	Planned	1959	.....	Italian	Firms
		Atmos. Dist., Vac. Dist. & Lube Oils	20,000 bbls.	$7,000,000	Planning	1960	.....	.....	.....
		Cat Reformer	3,000 bbls.	$2,700,000	Planning	1962	.....	.....	.....
		Hydrodesulfuriser	2,700 bbls.	$720,000	Planning	1962	.....	.....	.....
		Lube Oils	.....	$9,000,000	Planning	1963	.....	.....	.....
		Vapor Recovery & Bottling	70 tons	$1,000,000	Planned	1959	.....	Lummus	Lummus
	Alex	Atmos. & Vac. Dist.	10,000 bbls.	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmos. Dist. & Vac. Dist.	10,000 bbls.	$1,400,000	Planning	.....	.....	.....	.....
England									
British Petroleum	Kent	Hydrofiner II	10,000 bbls.	.....	Under Constr.	Mid 1958	.....	Kellogg	McAlpine, Wimpey
		Cat. Reformer	10,000 bbls.	.....	Complete	.....	.....	UOP, Kellogg	McAlpine,
		Thermal Reforming	12,000 bbls.	.....	Complete	.....	.....	Kellogg	Wimpey
		Udex Unit	500 bbls.	.....	Under Constr.	1958	.....	UOP, Badger	McAlpine, Wimpey
Eastern Gas Board	Ponders End.	Catalytic Oil Gasification	.....	.....	Under Constr.	.....	.....	Power-Gas	Power-Gas
Esso Petroleum	Fawley	Steam Cracker Butene Dehydrogenation Plant Ethylene Recovery Plant Butadiene Extraction Plant	40,000 lt. tons/yr	$27,000,000	Under Constr.	Mid 1958	.....	Foster Wheeler	Foster Wheeler
		Powerformer	21,000 bbls.	$12,000,000	Under Constr.	Early 1959	.....	Lummus	Lummus
		Sulfur Plant	60 tons	$700,000	Under Constr.	.....	.....	Foster Wheeler	Foster Wheeler
	Milford Haven	Refinery	100,000 bbls.	$52,000,000	Planning	Early 1960	.....	.....	.....
International Synthetic Rubber	Fawley	Synthetic Rubber	50,000 ton/yr.	$12,000,000	Under Constr.	.....	.....	Blaw Knox	Blaw Knox
Malta Gas Board	Valetta	Catalytic Oil Gasification	1 Mmcfd	.....	Under Constr.	Early 1959	.....	Power-Gas	Power-Gas
Mobil Oil Co., Ltd.	Coryton	Cat. Hydrodesulfurisation	.....	.....	Pre-engineering	.....	.....	.....	.....
		Crude Unit Exp.	5,000 bbls.	.....	Under Constr.	1958	.....	Staff	Staff
Monsanto Chemicals	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
North Thames Gas Board	Romford	Refinery Tail Gas Reforming	36 Mmcf	.....	Under Constr.	1958	.....	H & G	H & G
North Western Gas Board	Manchester Partington	Pressure Oil Gasification	7.5 Mmcf	.....	Engineering	Dec., 1959	Texaco & others	H&C	H&C
Petrochemicals, Ltd.	Partington, Nr. Manchester	Exp. Ethylene Plt.	30,000 tons/yr.	.....	Engineering	.....	.....	H.W.P.	H.W.P.
Shell Chemical	Shell Haven	Ammonia; Nitric Acid	75,000 tons/yr.	$18,500,000	Planning	1958	.....	.....	.....
		Fertiliser	.....	$12,500,000	Planning	.....	.....	.....	.....
	Partington	Ethylene Oxide	25,000 tons/yr.	.....	.....	1958	.....	.....	.....
Shell Refining	Shell Haven	Atmospheric Distil.	80,000 bbls.	.....	Under Constr.	Late 1958	.....	S&W; E. B. Badger, Ltd.	E. B. Badger, Ltd.
		Hydrodesulfuriser	16,000 bbls.	.....	Projected	1960	.....	.....	.....
	Stanlow	Udex Unit	.....	.....	.....	1958	UOP	.....	.....
South Eastern Gas Board	Isle of Grain	Oil Gasification	15 Mmcf	.....	Under Constr.	Fall 1958	.....	Power Gas	Power Gas
Southern Gas Board	Southampton	Refinery Tail Gas Reforming	16 Mmcf	.....	Under Constr.	1958	.....	H & G	H & G
	Reading	Catalytic Oil Gasification	7 mm cfd	.....	Under Constr.	Early 1959	.....	Power-Gas	Power-Gas
France									
Compagnie de Raffinage Shell Berre	Petit Couronne	Distl. Unit	80,000 bbls.	.....	Under Constr.	3rd Qtr., 1958	.....	.....	.....
		Hydrodesulfuriser	11,000 bbls.	.....	Under Constr.	4th Qtr. 1959	.....	.....	.....
		Platformer	14,000 bbls.	.....	Engineering	1959	.....	Procon	Procon
Shell-Berre	Berre	Furfural Unit	3,500 bbls.	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Comp Francaise de Raffinage	Provence	Powerformer	20,000 bbls.	.....	Under Constr.	1958	.....	Foster Wheeler	Foster Wheeler
Compagnie Francaise de Petrole; Compagnie Francaise de Raffinage; Pechelbronn Socantar	Normandie	Ethylene Plt.	30,000 tons/yr.	.....	Engineering	1958	.....	KIC	.....
	Strasburg	Refinery	70,000 bbls.	.....	Planning	.....	.....	.....	.....
Lorraine-Dieuze	.....	*Polyethylene	.....	.....	Under Constr.	.....	Koppers	Kuhlman	.....
(Moselle) Kuhlman									
Naphtachimie	Laverna	*Ethylene Oxide Expansion	31,000,000 lb./yr.	.....	Engineering	.....	Scientific Design	Societe Francais des Services Techniques	Societe Francais des Services Techniques
Esso Standard	Gironde Bordeaux	Refinery	31,500 bbls. Expandable to 45,000 bbls.	.....	Under Constr.	1959	Esso	Lummus	Lummus
Esso Standard	Port Jerome	Powerformer	11,900 bbls.	.....	Under Constr.	Late 1958	Esso	Foster Wheeler	Foster Wheeler
		Steam Cracker	5,000 bbls.	.....	Under Constr.	1959	Esso	Foster Wheeler	Foster Wheeler
		Dodecylbenzene Plant	13,500,000 tons/yr	.....	Under Study	Late 1958	Esso	Foster Wheeler	Foster Wheeler
Houilleres du Bassin de Lorraine	Carling	Acetylene Plt.	.....	.....	Under Constr.	.....	Koppers	SBA	SBA
		Styrene Monomer	.....	.....	Under Constr.	Early 1959	.....	SBA	SBA
Lorraine-Kuhlman	Dieuze (Moselle)	Polystyrolene	.....	.....	Under Constr.	.....	Koppers	Kuhlman	.....
Manufacture Normande de Polyethylene	Gonfreville	Polyethylene	.....	.....	Under Constr.	.....	Phillips	.....	S.T.E.C.
Marles-Kuhlmann	Gonfreville	Ethylene Oxide	.....	.....	Under Constr.	.....	Scientific Design	Staff	.....
Mobil Oil Francaise	Gravenchon	Lube Exp.	.....	.....	Engineering 2nd phase	1958			
					Planning 3rd phase	1959			
Omnium Francais de Petroles	Centre Est de la France	Refinery	75,000 bbls.	.....	Planning	.....	.....	.....	.....
Potasse et Engrais Chimiques	Grand Couronne	Ammonia	.....	.....	.....	.....	.....	Kellogg	Kellogg

* First appearance in tabulation. † Added capacity.

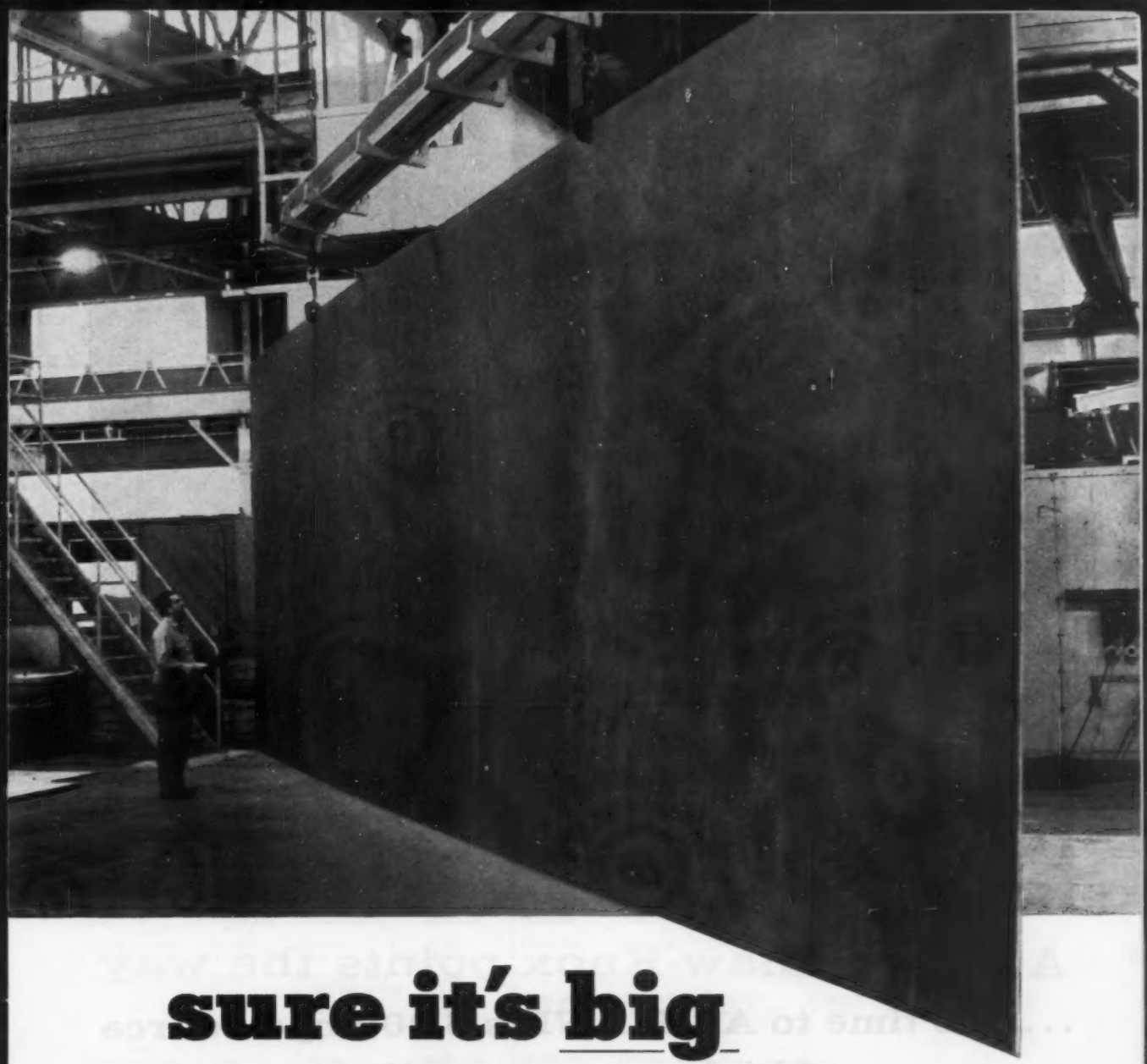
Construction BOXSCORE Continued on Page 184

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Societe des Produits d'Aquitaine	France	*Ammonia	200 tons	$6,000,000	Engineering	1959	.....	Chemico	Chemico
Societe du Caoutchouc Butyl	Port Jerome	Butyl Rubber Plt.	20,000 tons/yr.	.....	Under Constr.	Fall 1958	Esso	Braun	Braun
Soc. Francaise des Petroles BP	Dunkirk	Cat. Reformer	10,000 bbls.	.....	Under Constr.	1958	.....	UOP; Kellogg	.....
	Lavera	Distillation	50,000 bbls.	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Soc. Nationale des Petroles D'Aquitaine	Lacq	Desulfurization	†140 Mmcf	.....	Under Constr.	1958	.....	Foster Wheeler Soc. Chimique	Foster Wheeler Soc. Chimique
		Distill. Recovery with Prod. Treat, & Fract.	†90 Mmcf	.....	Complete	.....	.....	Hydrocarbon	Hydrocarbon
		Sulfur Recovery Phase 3	†780 tons	$22,000,000	Under Constr.	1958	Parsons	Parsons & Heurtey; Soc. Chimique	Soc. Chimique
		Desulfurization	175 Mmcf	.....	Engineering	1959	.....	Foster Wheeler Soc. Chimique	Foster Wheeler Soc. Chimique
		Distillation Recovery II	112 Mmcf	.....	Under Constr.	1959	.....	Hydrocarbon; Lummus	Hydrocarbon; Lummus
		Sulfur Recovery Phase II	970 tons	.....	Under Constr.	1958	Parsons	Parsons, Heurtey, Soc.	Parsons, Heurtey, Soc.
		Sulfur Recovery Phase III	.....	.....	Engineering	1959	.....	Parsons & Heurtey	Parsons & Heurtey
		Sulfur Recovery Phase IV	1,000 tons	.....	Engineering	1961	Parsons	Parsons & Heurtey	Parsons & Heurtey
		*Ethylene	25,000 tons/yr.	.....	Engineering	1960	.....	Hydrocarbon	Staff
East Germany									
Ministry of Coal & Energy	Rostock	Catalytic Oil Gasification	2.4 mm cfd	.....	Under Constr.	End 1958	.....	Power-Gas Didier	Power-Gas; Didier
West Germany									
B.P. Benzin und Pet A. G.	Dinslaken	Refinery	100,000 bbls.	.....	Engineering	1960	.....	Kellogg	.....
Bune Werke Huels G.m.b.H.	Marl, Kreis Recklinghausen	Synthetic Rubber Plt.	45,000 tons/yr.	$37,000,000	Under Constr.	1958	Esso; R&E Houdry; Firestone	Staff	Staff
Chemische Fabrik Holten GmbH	Lubwigshaven a Rein, Germany	Ethylene Oxide	9,000,000 lbs./yr.	.....	Under Constr.	.....	Scientific Design	Scientific Design	.....
Chemische Werke Huls	Marl	Polyethylene Plant	6,000 tons/yr	.....	Planning	Summer 1959	Ziegler	Staff	Staff
Deutsche Erdol.....	Heide/Holstein	Propane-Propylene Separation	7,000 tons/yr. Propylene	.....	Under Constr.	3rd Qtr., 1958	Calif. Res. Hydrocarbon	Hydrocarbon, Hydro M	Staff
Deutsche Shell.....	Harburg	New Refinery with Crude Distiller Cat. Reformer Hydrodesulfurization	40,000 bbls.	.....	Under Constr.	4th Qtr., 1958	.....	.....	.....
Erdolchemie GmbH...	Dormagen (Nierderrnein)	*Gasoline	65,000 tons/yr.	.....	Under Constr.	1958	Lurgi/ Scientific Design	Lurgi/Scientific Design	.....
		Platformer	6,700 bbls.	.....	Under Constr.	1958	UOP	UOP Procon	Procon
	Godorf	Refinery	30,000 bbls.	.....	Under Constr.	1960	.....	.....	.....
Esso A. G.....	Cologne	Refinery	72,000 bbls.	$39,000,000	Under Constr.	Spring 1959	Esso	Braun, Uhde, Lurgi	Braun & Others
		Atmospheric Crude Distill.	.....	.....	.....	.....	.....	G.H.H.	.....
		Powerformer	9,000 bbls.	.....	.....	.....	.....	.....	.....
		Gas-Oil Hydrofiner	12,000 bbls.	.....	Under Constr.	Late 1958	.....	Kocks, Still	Esso
		Steam Cracker	5,600 bbls.	.....	Under Constr.	Late 1958	.....	Lurgi	Esso
		Sulfur Recovery	8,900 tons/yr	.....	.....	.....	.....	.....	.....
	Hamburg	*Oil Sweetening Plant	7,700 bbls.	.....	Under Constr.	.....	Esso	Lurgi	.....
		*Solvents Hydrofiner	3,040 bbls.	.....	Under Constr.	.....	Esso	Lurgi	.....
Feldmuhle.....	Luisdorf	Ethylene	10,000 tons/yr.	.....	Engineering	End 1958	.....	Hydrocarbon Hydro M	Hydro M
Frisia.....	Emden, W. Germany	Refinery	30,000 bbls.	$17,000,000	Engineering	1959	.....	Parsons	Parsons
Gewerkschaft Erdoel Raffinerie Emsland	Lingen-Holthausen	Exp. Refinery	32,000 bbls.	$25,000,000	Under Constr.	1960	U.O.P., Lurgi	Lummus, Lurgi	Lummus, Lurgi
Mobil Oil A. G.....	Bremen Oslebhausen	Crude Two Stage	16,000 bbls.	.....	Under Constr.	1958	.....	Hydrocarbon Hydro M	Hydro M
Purfina Mineraloil-raffinerie A. G.	Duisburg	Topping, Platformer Hydrodesulfurizer	20,600 bbls.	.....	Complete	.....	UOP, Shell	Lummus; Uhde	Lummus; Uhde
Rheinische Olefinwerke GmbH	Wesseling	*Polyethyene Plant	.....	.....	Engineering	Late 1959	Phillips	Braun	.....
		*Ethylene Plant	.....	.....	Under Constr.	Fall, 1958	Kellogg	Lurgi	.....
Ireland									
Irish Refining Co..... Esso Petr. (Ireland) Caltex (Ireland) Shell Mex., B.P.	Whitegate	Refinery	32,000 bbls.	$33,600,000	Approved	1959	.....	.....	.....
Italy									
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Styrene Monomer Plt.	14,000 tons/yr.	.....	Under Constr.	.....	Koppers	SBA	SBA
		Butadiene Plt.	22,000 tons yr.	.....	Engineering	Fall, 1959	Houdry	Catalytic	.....
		*Ethylene Plant	.....	.....	Under Constr.	.....	Koppers	ANIc	.....
Destillerie Italiane...	Milano	Butanol	11,000 tons/yr.	.....	Engineering	.....	Hoechst	Uhde	Uhde
Ftalital, S.p.a.....	Italy	*Maleic Anhydride	2,200,000 lb./yr.	.....	Engineering	.....	Scientific Design	Scientific Design	.....
I.R.O.M.....	Venice	Hydrofiner	6,500 bbls.	.....	Engineering	1959	.....	SNAM	SNAM
Isiom.....	Palermo	Refinery	15,000 bbls.	.....	Planning	1958	.....	Staff	.....
Mobil Oil Italiana S. p.a	Naples	Cat. Reforming	9,000 bbls.	.....	Under Constr.	1958	.....	CTIP	CTIP
		Cat. Hydrodesulfurisation	10,000 bbls.	.....	Under Constr.	1958	.....	CTIP	CTIP
		Lube Expansion	.....	.....	Under Constr.	1958	.....	Staff	Staff
Montecatini Societe Generale per l'Industria Mineraria Chimica	Ferrara	Exp. Polypropylene	.....	.....	Planning	1959	.....	.....	.....
	Castellanza	Increase Formaldehyde	135,000,000 lbs/yr	$300,000	Under Constr.	.....	.....	.....	.....
Shell Italiana.....	Palermo	Refinery	20,000 bbls.	.....	Planning	.....	.....	.....	.....
Sincat.....	Priolo, Sicily	Ammonia Unit	150 tons	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Soc. Solvay & Cie	Italy	Polyethylene	.....	.....	Licensed	.....	Phillips	.....	.....
STANIC Industria Petrolifera	Livorno	Hydrofiner	8,200 bbls.	$1,600,000	Complete	.....	Esso	CTIP	CTIP
Netherlands									
B. F. Goodrich & Algemene Kunstsijde Unie	Arnheim	Butadiene	.....	.....	.....	Mid 1959	.....	.....	.....
Kunstsijde Unie N.V.	.....	Styrene Plant	.....	.....	.....	.....	.....	.....	.....
Esso Nederland.....	Rotterdam	Refinery	95,000 bbls.	$50,000,000	Under Constr.	Early 1960	Esso	Badger Comprimo N.V.	Badger, Comprimo N.V.
Norway									
Standard (N.J.).....	Oslo Fjord	Refinery	40,000 bbls.	$30,715,000	Engineering	Late, 1960	Esso	Esso	.....
Portugal									
Ammoniaco Portugues	Estarreja.	Ammonia	40 tons	.....	Under Constr.	1958	Uhde	Uhde	Uhde

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 187



sure it's big

. . . but not particularly big or unusual in Carlson's production of stainless steel plate

IT was normal, but not easy, for Carlson specialists to handle this big plate. Type 304-L stainless, it measured 7/16" x 131 1/2" x 452 9/16" and weighed an impressive 7923 pounds. And when this big one landed at the customer's receiving dock it was *exactly* what he wanted . . . *right* by chemical composition, *right* by physical standards, *right* to specification and *right* to size.

Whatever you need in stainless steel—big plates, small rings, formed or cut-to-shape items—will be produced accurately and on time. Stainless steel is our *only* business, and we know it. That is why you can depend on Carlson to give you *what you want when you want it!* Your inquiry is invited.

G.O.CARLSON *Inc.*

Stainless Steels Exclusively

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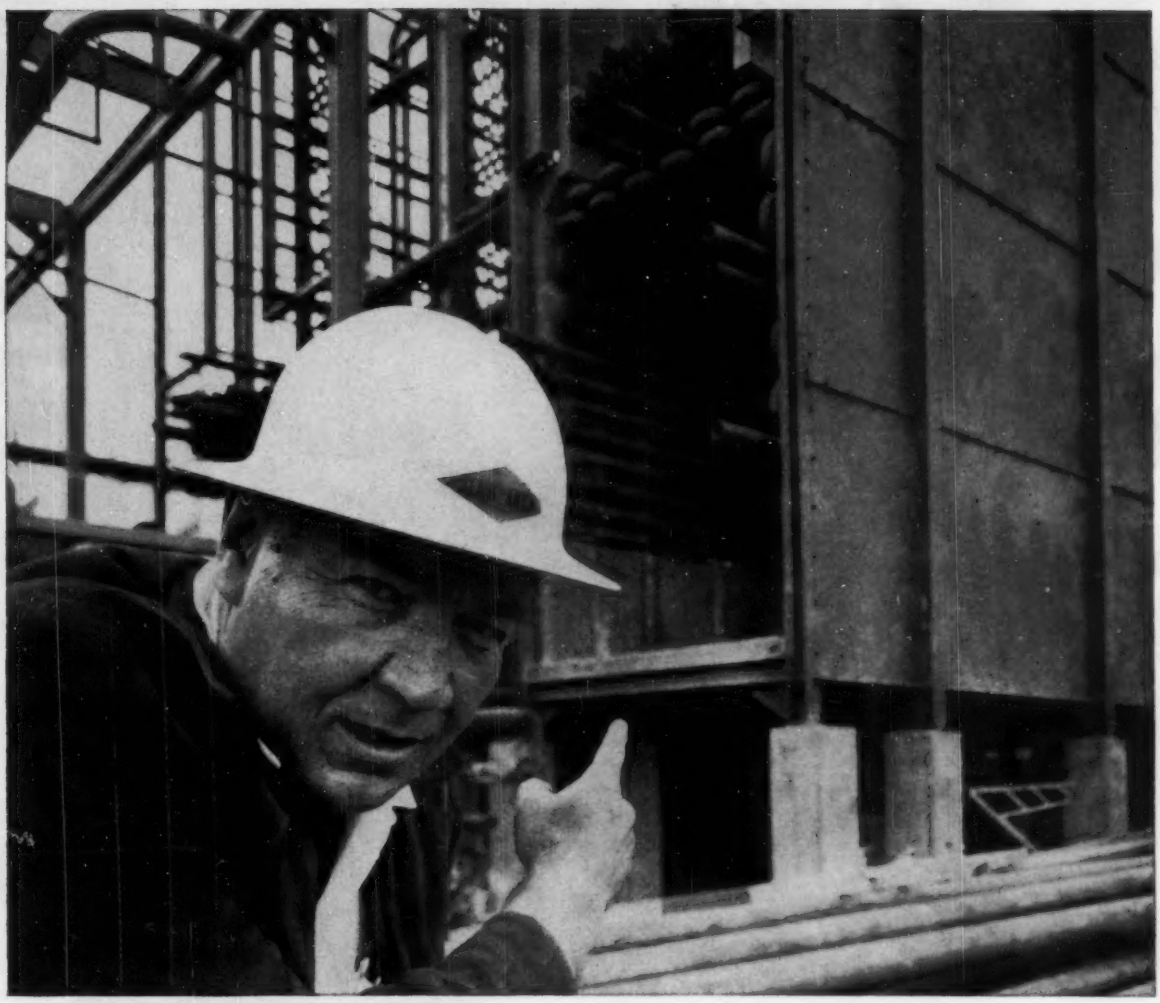
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)



AGAIN—Blaw-Knox points the way

. . . this time to ASHLAND's 6,000 bpd source of high octane gasoline

The catalytic reforming and hydrogen desulfurization unit, now in operation, is the latest of eight Blaw-Knox units which are operating successfully in the petroleum industry—to supply high octane gasoline for today's high compression motors. Engineered, constructed and installed by Blaw-Knox, it provides a capacity of 6,000 bpd in the Buffalo Refinery of the Frontier Oil Refining Division of Ashland Oil and Refining Company.

The wide experience of Blaw-Knox engineers in catalytic reforming, as well as other petroleum and chemical processes, is always available to you. We welcome the opportunity to discuss your proposed modernization, expansion or new plant projects with you—and to offer our recommendations.

Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, N. J., Birmingham, Washington, D. C., San Francisco.

for plants of distinction . . .

BLAW-KNOX

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Portuguese W. Africa									
Scotland									
British Hydrocarbon Chemicals	Grangemouth	Polyethylene Plt.	25,000,000 lbs./yr.	.....	Under Constr.	Early 1959	Phillips	S & W	.....
		Cumene Plt.	.....	.....	Engineering	Mid 1959	Mid-Century Corp.	Scientific Design	.....
		Phenol	.....	.....	Engineering	1959	Distillers Co., Ltd.	S & W S & W	.....
Britoil Petroleum...	Grangemouth	Copper Chloride Unit	2,000 bbls.	.....	Under Constr.	Late 1958	.....	Power-Gas	Power-Gas
		Kerosine Treating	2,000 bbls.	.....	Under Constr.	Late 1958	.....	Power-Gas	Power-Gas
		Desthanizer	625 bbls.	.....	Under Constr.	Late 1958	.....	Power-Gas	Power-Gas
Spain									
Hidro Nitro Espanola Refineria de Petroleos de Escombreras S.A.	Monzon Escombreras	Ammonia Synthesis	22 tons	.....	Under Constr.	1958	.....	Uhde	Uhde
Sweden									
A. Johnson & Co....	Sweden	Refinery Exp.	.....	.....	Under Constr.	.....	.....	Bechtel	Bechtel
Stockholm Gas & Water Works	Stockholm	Cat Oil Gasification	4 Mmcf	.....	Under Constr.	Mid 1959	Power Gas	.....	Power Gas
Turkey									
Badische Anilin and Soda Fabrik	Kutahya	Ammonium Sulfate Sulfuric, Nitric Acid	60,000 tons/yr. 50,000 tons /yr.	$20,000,000	Under Constr.	1958	Badische Anilin & Soda-Fabrik AG	Badische Anilin & Soda-Fabrik AG.	.....
Mobil Overseas, Shell, Cal-Tex, BP	Turkey	Refinery	65,000 bbls.	$48,000,000	Under Constr.	1958	.....	.....	.....
Turkish Government.	Istanbul	Natural Gasoline Plt.	.....	.....	Planning	.....	.....	.....	.....
Union of South Africa									
Standard-Vacuum....	Durban	Refinery Exp.	25,000 bbls.	$9,000,000	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
		Powerformer	.....	.....	.....	.....	.....	.....	.....
		Hydrofiner	.....	.....	.....	.....	.....	.....	.....
		Steam Plt.	.....	.....	.....	.....	.....	.....	.....
Yougoslavia									
Yougoslav Government	Dubrovnik	Distill. and Treating	1,350 bbls.	$1,350,000	Planning	1960	.....	Institute of Petroleum at Zagrel	.....
	Sisak	Topping and Stabilising	7,500 bbls.	.....	Planning	1961	.....	Institute of Petroleum at Zagrel	.....
		Ammonia Plt.	120 Tons	$15,000,000	Planning	1962	.....	.....	.....
	Pancevo	Ammonia Plt.	240 Tons	.....	Planning	1962	.....	.....	.....
	Zagrel	Reformer	.....	.....	Planning	.....	.....	.....	.....
NEAR EAST									
Iraq									
Iraq Government.....	Baghdad	Refinery Exp.	48,000 bbls.	$11,000,000	Under Constr.	July, 1959	Esso	Foster Wheeler	Foster Wheeler
		Powerformer	5,000, bbls.	.....	.....	Sept., 1958	.....	Foster Wheeler, Ltd.	Foster Wheeler, Ltd.
		Kerosine Treating Unit	5,000 bbls.	.....	.....	Sept., 1960	.....	Foster Wheeler	Foster Wheeler
	Qaiyarah	Refinery Revamp Crude Topping; Vacuum Distill.; Thermal Cracking; Asphalt	7,500 bbls.	.....	Planning	Late 1960	.....	.....	.....
Israel									
Fertilizers & Chemicals, Ltd.	Haifa Bay	Ammonia Plt. Exp Fertilizers	50 tons	$5,000,000	Engineering	1959	.....	Staff Lurgi	Local
Kuwait									
Kuwait Oil	Mina al Ahmedi	Hydrobon Platformer	4,070 bbls.	.....	Under Constr.	Early 1959	UOP	Procon	Bechtel
		Prefractionator	7,200 bbls.	.....	Engineering	Early 1959	UOP	Procon	Procon
Neutral Zone									
Getty Oil Co.	Neutral Zone	Crude Stripping	80,000 bbls.	$2,000,000	Under Constr.	1958	.....	Parsons	Parsons
Pakistan									
Pakistan Industrial Dev. Corp.	Fnchanj, Pakistan	*Ammonia *Urea	225 tons 375 tons	$20,000 000	Engineering	1961	Kobe Steel	Chemico	Chemico
Saudi Arabia									
Arabian American Oil	Abqaic	*Expansion Crude Stabilization Unit	950,000 bbls.	.....	.....	.....	.....	.....	.....
	Ras Tanura	*Alkylation Unit	1,210 bbls.	$6,990,000	Under Constr.	Mid 1959	Kellogg	Kellogg/Aramco	Staff
		*LPG Processing Handling, and Loading Facilities	1,500 bbls.	$1,025,000	Under Constr.	January, 1959	Kellogg	Staff	Staff
Syria									
Syrian Government..	Homs	Refinery	20,000 bbls.	$11,000,000	Planning	.....	.....	.....	.....
FAR EAST									
Ceylon									
Shell of Ceylon.....	Hendola	Refinery	.....	$40,000,000	Planning	.....	.....	.....	.....
China									
Hong Kong & China Gas Company	Hong Kong	Catalytic Oil Gasification	1.5 mm cfd	.....	Under Constr.	Autumn 1958	.....	Power-Gas	Power-Gas
India									
Alkali & Chemical Corp. of India	India	Polyethylene Plt.	.....	$6,300,000	Under Constr.	Early 1959	I. C. I.	.....	Simon Carves, Ltd.
New Central Jute Mills	Varanasi	Ammonia	45 tons	.....	Under Constr.	.....	Uhde	Uhde	Uhde
Standard Vacuum....	Bombay	Asphalt Plant	.....	$2,500,000	Engineering	Late 1960	.....	Parsons	Parsons
Japan Far East									
Asahi-Dow.....	Kawasaki	*Styrene Monomer	.....	.....	Under Constr.	1960	Dow	Dow	Dow
Befu Chemical.....	Befu Harbor Honshu	Ammonia Plt.	.....	.....	Under Constr.	.....	Texaco	Chemico	Chemico
Daiichi Bussan Kaisha, Ltd.	Iwakuni	*Phenol Plant	12,000 tons/yr.	.....	Complete	.....	Distillers	Stone & Webster	Mitsui Shipbuilding Co.
		*Terephthalic Acid Plant	.....	.....	Under Constr.	Sept. 1959	Scientific Design	Scientific Design	Mitsui Shipbuilding Co.
		*Paraxylene Plant	.....	.....	Engineering	Sept., 1959	Scientific Design	Scientific Design	.....
Daikyo Oil Co.....	Yokkaichi	*Houdriformer	3,000 bbls.	$2,200,000	Complete	.....	Houdry	Treco	Chiyoda
		*Topping & Vacuum	30,000 bbls.	.....	Engineering	Mid 1959	.....	Japan Gasoline	Japan Gasoline
Furukawa Chemical Industries	Japan	Polyethylene	.....	.....	Approved	.....	Phillips	.....	.....
Idemitsu Kosan Co...	Tokuyama	Unifiner	6,000 bbls.	$370,000	Engineering	1958	UOP	UOP; J.G.C.	J.G.C.
Japan Synthetic Rubber	Yokkaichi	Butadiene & GR-S Rubber Plant	33,500 tons/yr	$30,000,000	Engineering	1959	Houdry Esso Goodyear	Blaw-Knox; Catalytic	.....

* First appearance in tabulation. † Added capacity.

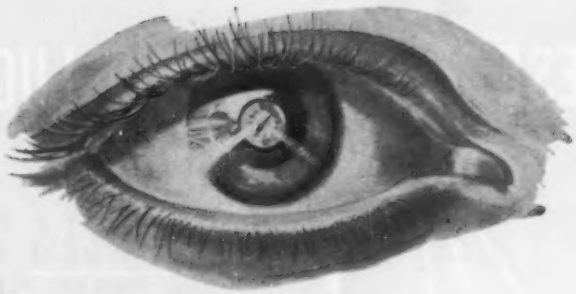
Construction BOXSCORE Continued on Page 188

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Koa Oil.	Iwakuni	Cat. Reformer	4,000 bbls.	$2,200,000	Planning	Mid 1959	.....	.....	.....
		*Fluid Cat Cracker	5,500 bbls.	.....	Planning	Late 1959	.....	.....	.....
		*Delayed Coker							
		*(Thermal Cracker revamp)	4,500 bbls.	.....	.....	.....	.....	.....	.....
Maruzen Oil Co.....	Matsuyama	Udex Unit	1500 bbls.	$2,200,000	Under Constr.	1958	UOP	UOP; Japan Gasoline Co.	J.G.C.
		Benzene	6 600 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Toluene	4,000 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Xylene	4,000 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Oxidation Unit	30 tons	$4,000,000	Engineering	March, 1959	Scientific Design	Scientific Design	Scientific Design
		Benzoic Acid	900 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Phthalic Acid Anhydride	2,245 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Isophthalic Acid	5,600 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Terephthalic Acid	2,500 tons/yr.	.....	.....	April, 1960	Scientific Design	.....	.....
	Osaka	*Ethyl Ketone	15 tons	$3,000,000	Complete	.....	.....	Chemical Projects Assoc.	Chiyoda
		*Secondary Butyl *Alcohol	15 tons						
Mitsui Petrochemical Industries	Iwakuni City	Phenol Unit	1,000 tons	.....	Under Constr.	.....	Distillers, Ltd.	S&W	S&W
		Terephthalic Acid	.....	.....	.....	1958	Scientific Design	.....	.....
		Cat Reformer	.....	.....	Licensed	.....	.....	.....	.....
		Paraxylene Plant	.....	.....	.....	Summer 1959	.....	Scientific Design	.....
Mitsubishi Petrochemical Co.	Yokkaichi	Styrene Monomer	55.4 tons	.....	Under Constr.	Jan., 1959	B.P.M.	B.P.M.; Chiyoda	B.P.M.; Chiyoda
		Ethylene Oxide	9.2 tons	.....	Engineering	.....	Scientific Design	Scientific Design	.....
		Ethylene Glycol	9.2 tons	.....	Engineering	.....	Scientific Design	Scientific Design	.....
Nihon Gas Kagaku Kogyo	Niigata	Urea	95 tons	.....	.....	.....	.....	Chemico	Chemico
		Ammonia Sulfate	200 tons	.....	.....	.....	.....	Chemico	Chemico
Nippon Oil Co.....	Niigata	Platformer	1,600 bbls.	$1,500,000	Engineering	1958	UOP	UOP; J.G.C.	UOP; J.G.C.
Nippon Petroleum Refining	Yokohama	Lube Oil Furfural Unit	700 bbls.	$1,000,000	Under Constr.	1958	Texaco	Chiyoda	Chiyoda
Nippon Petrochemicals	Kawasaki	Ethylene	25,000 tons/yr.	$16,000,000	Engineering	Spring, 1959	S&W Esso	S&W; J.G.C.	S&W; J.G.C.
		Butadiene	5,000 tons/yr.						
Showa Denko KK..	Tokyo	Synthesis Gas Plt.	121 Short tons	.....	.....	.....	Texaco	Foster Wheeler	Foster Wheeler
Showa Yuka.....	Japan	Polyethylene	.....	.....	Under Constr.	1st Qtr. 1959	Phillips	Staff, Braun	.....
Toa Nenryo Kogyo...	Shimizu	Ref. Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	43,500 bbls.	$12,500,000	Under Constr.	Late 1958	.....	.....	.....
Korea									
Korean Government..	Chung-ju	Urea Plt.	285 tons	$25,000,000	Under Constr.	1958	Inventa-Vulcan	Hydrocarbon, McGraw, Vulcan	Hydrocarbon, McGraw
Taiwan (Formosa)									
Chinese Petroleum Corp.	Kaohsiung	Alkylation Unit	900 bbls.	$1,600,000	Engineering	1958	Texaco	Badger	Staff
		Sulfur Recovery Unit	10 tons	$300,000	Engineering	1958	.....	Pintsch Bamag	Staff
Thailand									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls.	$20,000,000	.....	.....	.....	Japanese Fuji Company	Japanese Fuj Company
AUSTRALASIA									
Australia									
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls	.....	Under Constr.	.....	.....	UOP	Staff
		Crude Unit	12,000 bbls.	.....	Proposed	1958	.....	Procon	Procon
BP Refinery (Kwinana)	Kwinana	Cat. Reformer	10,000 bbls.	$9,200,000	Under Constr.	End 1958	.....	UOP, Kellogg	Kellogg
Imperial Chemical Industries of Australia & New Zealand	Australia	Polyethylene Plt.	3,500 tons/yr.	$5,040,000	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Platformer	6,700 bbls.	.....	Under Constr.	4th Qtr., 1958	UOP	.....	Procon
	Geelong	Hydrodesulfuriser	11,000 bbls.	.....	Projected	3rd Qtr., 1959	.....	.....	.....
Standard Vacuum....	Melbourne	Refinery Revamp	.....	.....	Under Constr.	Mid 1959	.....	Fluor	Fluor
	Adelaide	Refinery	30,000 bbls.	$30,000,000	Planning	.....	.....	.....	.....
Philippine Islands									
Gulf Oil.....	Luzon	Refinery	10,000 bbls.	.....	Planning	Late 1960	.....	.....	.....
Shell (Philippines)....	Manila	Refinery	.....	.....	Negotiating	.....	.....	.....	.....
Standard-Vacuum....	Bataan	Refinery	21,000 bbls.	$33,500,000	Planning	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE:
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Badger Mfg.—Badger Manufacturing Co.
Badger N. V.—Badger-Comprime N. V.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
C. J. B. —Constructors John Brown, Ltd.
Consol. Eng.—Consolidated Engineering Company
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services Inc.
E&A—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M. B. H.
Etabadger S.A.—Etablissement Badger, S.A.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Ford, Bacon, Davis—Ford Bacon & Davis Construction Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—Girdler Construction Division
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
J.G.C.—Japan Gasoline Co.
Hedrick—Wyatt C. Hedrick Engineering Corp.
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H&G—Humphreys & Glasgow, Ltd.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineraloel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P. A.—Kellogg Pan American
KIC—Kellogg International Corp.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kidde Constr.—Walter Kidde Constructors, Inc.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G.m.b.H.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
Olsen—O. L. Olsen
Parsons—The Ralph M. Parsons Co.
Pet. Comb. & Eng. Co.—Petroleum Combustion & Engineering Co.
Petreco—Petroleum Construction Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
Scientific Design—Scientific Design Co.
Soc. Chimique—Societe Chimique de la Grande Paroisse
Southwestern—Southwestern Constr. Co.
Stearns-Roger—Stearns-Roger Mfg. Co.
S & W—Stone & Webster Engineering Corp., Chemical Division
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Sweco—Southwestern Engineering Co.
Tears—Tears Engineers
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Tuloma—Tuloma Builders
Uhde—Friedrich Uhde, G.m.b.H.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.



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For more data on advertised products, use Readers' Service Cards, last page.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Kon Oil.	Iwakuni	Cat. Reformer	4,000 bbls.	$2,200,000	Planning	Mid 1959	.....	.....	.....
		*Fluid Cat Cracker	5,500 bbls.	.....	Planning	Late 1959	.....	.....	.....
		*Delayed Coker							
		*(Thermal Cracker revamp)	4,500 bbls.	.....	.....	.....	.....	.....	.....
Maruzen Oil Co.....	Matsuyama	Udex Unit	1500 bbls.	$2,200,000	Under Constr.	1958	UOP	UOP; Japan Gasoline Co.	J.G.C.
		Benzene	6 600 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Toluene	4,000 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Xylene	4,000 tons/yr	.....	.....	Dec. 1958	UOP	.....	.....
		Oxidation Unit	20 tons	$4,000,000	Engineering	March, 1959	Scientific Design	Scientific Design	Scientific Design
		Benzoic Acid	900 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Phthalic Acid Anhydride	2,245 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Isophthalic Acid	5,600 tons/yr	.....	.....	April, 1960	Scientific Design	.....	.....
		Terephthalic Acid	2,500 tons/yr.	.....	.....	April, 1960	Scientific Design	.....	.....
	Osaka	*Ethyl Ketone	15 tons	$3,000,000	Complete	.....	.....	Chemical Projects Assoc.	Chiyoda
		*Secondary Butyl Alcohol	15 tons						
Mitsui Petrochemical Industries	Iwakuni City	Phenol Unit	1,000 tons	.....	Under Constr.	.....	Distillers, Ltd.	S&W	S&W
		Terephthalic Acid	.....	.....	.....	1958	Scientific Design	.....	.....
		Cat Reformer	.....	.....	Licensed	.....	.....	.....	.....
		Paraxylene Plant	.....	.....	.....	Summer 1959	.....	Scientific Design	.....
Mitsubishi Petrochemical Co.	Yokkaichi	Styrene Monomer	55.4 tons	.....	Under Constr.	Jan., 1959	B.P.M.	B.P.M.; Chiyoda	B.P.M.; Chiyoda
		Ethylene Oxide	9.2 tons	.....	Engineering	.....	Scientific Design	Scientific Design	.....
		Ethylene Glycol	9.2 tons	.....	Engineering	.....	Scientific Design	Scientific Design	.....
Nihon Gas Kagaku Kogyo	Niigata	Urea	95 tons	.....	.....	.....	.....	Chemico	Chemico
		Ammonia Sulfate	200 tons	.....	.....	.....	.....	Chemico	Chemico
Nippon Oil Co.....	Niigata	Platformer	1,600 bbls.	$1,500,000	Engineering	1958	UOP	UOP; J.G.C.	UOP; J.G.C.
Nippon Petroleum Refining	Yokohama	Lube Oil Furfural Unit	700 bbls.	$1,000,000	Under Constr.	1958	Texaco	Chiyoda	Chiyoda
Nippon Petrochemicals	Kawasaki	Ethylene	25,000 tons/yr.	$16,000,000	Engineering	Spring, 1959	S&W Esso	S&W; J.G.C.	S&W; J.G.C.
		Butadiene	5,000 tons/yr.						
Showa Denko KK..	Tokyo	Synthesis Gas Plt.	121 Short tons	.....	.....	.....	Texaco	Foster Wheeler	Foster Wheeler
Showa Yuka.....	Japan	Polyethylene	.....	.....	Under Constr.	1st Qtr. 1959	Phillips	Staff, Braun	.....
Toa Nenryo Kogyo...	Shimizu	Ref. Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	43,500 bbls.	$12,500,000	Under Constr.	Late 1958	.....	.....	.....
Korea									
Korean Government..	Chung-ju	Urea Plt.	285 tons	$25,000,000	Under Constr.	1958	Inventa-Vulcan	Hydrocarbon, McGraw, Vulcan	Hydrocarbon, McGraw
Taiwan (Formosa)									
Chinese Petroleum Corp.	Kaohsiung	Alkylation Unit	900 bbls.	$1,800,000	Engineering	1958	Texaco	Badger	Staff
		Sulfur Recovery Unit	10 tons	$300,000	Engineering	1958	.....	Pintsch Bamag	Staff
Thailand									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls.	$20,000,000	.....	.....	.....	Japanese Fuji Company	Japanese Fuj Company
AUSTRALASIA									
Australia									
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls	.....	Under Constr.	.....	.....	UOP	Staff
		Crude Unit	12,000 bbls.	.....	Proposed	1958	.....	Procon	Procon
BP Refinery (Kwinana)	Kwinana	Cat. Reformer	10,000 bbls.	$9,200,000	Under Constr.	End 1958	.....	UOP, Kellogg	Kellogg
Imperial Chemical Industries of Australia & New Zealand	Australia	Polyethylene Plt.	3,500 tons/yr.	$5,040,000	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Platformer	6,700 bbls.	.....	Under Constr.	4th Qtr., 1958	UOP	.....	Procon
	Geelong	Hydrodesulfurizer	11,000 bbls.	.....	Projected	3rd Qtr., 1959	.....	.....	.....
Standard Vacuum....	Melbourne	Refinery Revamp	.....	.....	Under Constr.	Mid 1959	.....	Fluor	Fluor
	Adelaide	Refinery	30,000 bbls.	$30,000,000	Planning	.....	.....	.....	.....
Philippine Islands									
Gulf Oil.....	Luzon	Refinery	10,000 bbls.	.....	Planning	Late 1960	.....	.....	.....
Shell (Philippines)....	Manila	Refinery	.....	.....	Negotiating	.....	.....	.....	.....
Standard-Vacuum....	Bataan	Refinery	21,000 bbls.	$33,500,000	Planning	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE:

Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Badger Mfg.—Badger Manufacturing Co.
Badger N. V.—Badger-Comprimo N. V.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
C. J. S. —Constructors John Brown, Ltd.
Consd. Eng.—Consolidated Engineering Company
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services Inc.
E&A—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M. B. H.
Etabadger S.A.—Etablissement Badger, S.A.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Ford, Bacon, Davis—Ford Bacon & Davis Construction Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—Girdler Construction Division
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
J.G.C.—Japan Gasoline Co.
Hedrick—Wyatt C. Hedrick Engineering Corp.
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H&G—Humphreys & Glasgow, Ltd.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineralolel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P. A.—Kellogg Pan American
KIC—Kellogg International Corp.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kidde Constr.—Walter Kidde Constructors, Inc.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G.m.b.H.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
Olsen—O. L. Olsen
Parsons—The Ralph M. Parsons Co.
Pet. Comb. & Eng. Co.—Petroleum Combustion & Engineering Co.
Petreco—Petroleum Construction Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
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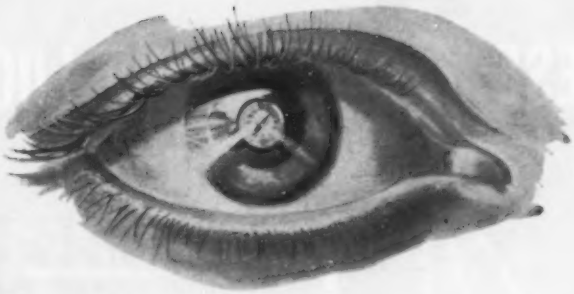
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
Scientific Design—Scientific Design Co.
Soc. Chimique—Societe Chimique de la Grande Paroisse
Southwestern—Southwestern Constr. Co.
Stearns-Roger—Stearns-Roger Mfg. Co.
S & W—Stone & Webster Engineering Corp., Chemical Division
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Swco—Southwestern Engineering Co.
Tears—Tears Engineers
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Tuloma—Tuloma Builders
Uhde—Friedrich Uhde, G.m.b.H.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.



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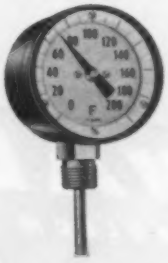

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Don't Give Training the Ax!

It is shortsightedness on management's part to try and cut plant costs by eliminating or curtailing training which is really needed

Ralph G. Smith
The Dow Chemical Company, Midland, Michigan

WHEN "BUSINESS is booming," most companies develop considerable enthusiasm for training maintenance and engineering people. They're willing to take one of the newer promising men from the personnel or engineering department or even hire a young, inexperienced, personable young college graduate and give him the task of setting up some sort of training for the plant. In this case, training is usually only one of his many responsibilities.

Probably not much attention has been given to why training is really needed or if it is even needed at all, but the company is doing well financially. The shop superintendent or the plant engineer has been plugging for some training for his men for many years, so management decides it probably won't hurt anything to spend a little money on training and see what happens.

What does happen? About the time this young trainer is half-way organized and starting to launch his program, the company's business begins to lose some of its "boom," so management decides to curtail the training program or eliminate it completely until the company can better afford it. "Out the window" goes the training program—and "out the window" goes a good opportunity for increased efficiency, lower costs, better morale, more capable men, less supervision, lower turnover rate, and so forth. Too bad!

Slash Goes the Ax. This may not have happened in your company, but it has happened enough to conclude that often the curve of training activities takes a nose dive the minute a dip occurs in the dollar volume of the sales curve. It then starts an incline only after sales have shot up once again and have stayed there awhile.

Of course, this is not to imply investment in training should have no relation to the financial position of the company. That would be absurd! What this does mean is that training is a marvelous tool which will increase the efficiency of operations, and often a company is much wiser to accelerate its training efforts rather than curtail them when faced with a necessity of cutting costs.

If there is a proven need for training and the training program is sound and practical, then it is short sightedness on the part of management to curtail or eliminate training as a means of cutting plant costs! To do so is to eliminate the very tool that could cut plant costs!

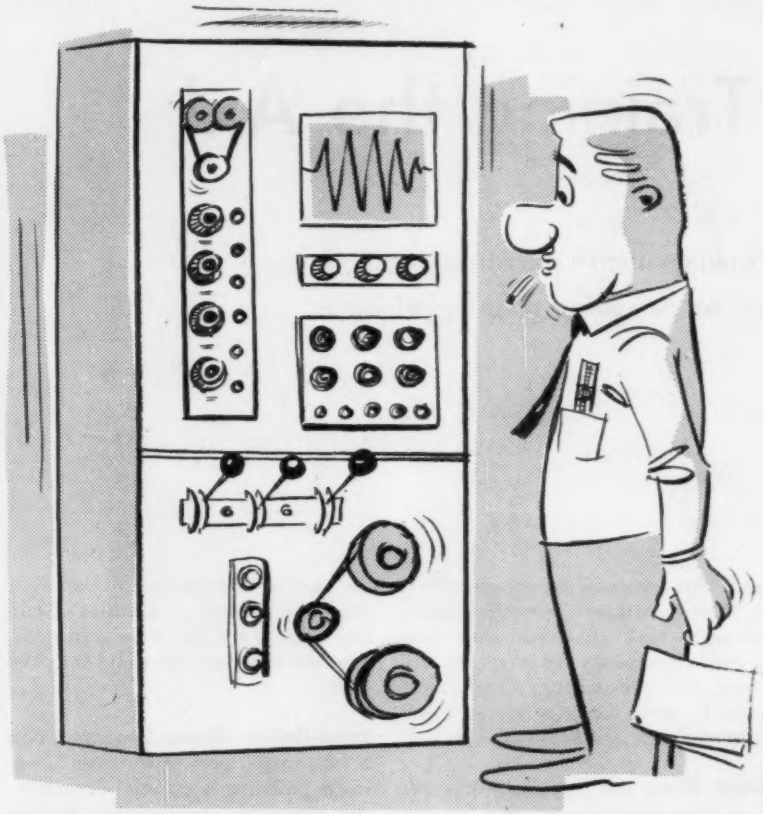
Long-Range View. You must take a long-range view of training. Long-range planning is essential in production, research, engineering, maintenance of plants and equipment, and in many other areas. Training must be considered on a long-range basis also if it is to contribute fully toward the success of the company.

It's a temptation to make training an "on again-off again" proposition! But this is too costly! No company can afford to do that in these times.

Manpower—A Shortage Coming? Let's take a quick long range look at the skilled manpower picture, taking the 10-year period from 1955 through 1965.

In 1955 the population of the U. S. was 165 million and the gross national product was $391 billion. By 1965 the population will exceed 193 million and we'll need a gross national product of $560 billion (1955 dol-

lars). In order to achieve this production increase, we must add 10 million workers to the labor force. With the population increasing by 28 million during this period, it appears to be no problem to increase the labor force by 10 million. However, real problems arise when we consider this question: Will they be the highly skilled, highly trained people that will be needed for our rapidly advancing technology?



Will your workers be the highly skilled, highly trained people needed for our rapidly advancing technology?

Our need for trained people increases in proportion to the complexity of our machines. Technology has not replaced people—it has demanded more highly skilled people!

Of the 10 million additional workers needed in the labor force between 1955-1965, about 2 million represent needed skilled craftsmen and about 2 million represent needed technical and professional people.

A Startling Fact. Now, there are two very alarming problems we must face in this 10-year period, 1955-1965. The first is that there will be *no increase in the number of men in the prime working ages between 25 and 44.*

This is a startling fact! Then where will we get 2 million more skilled craftsmen and 2 million more technical and professional men during this 10-year period? Obviously we'll have to train more of the men we already have and also train men outside of this 25-44 age group.

The second problem is that between 1951 and 1956 there was no increase in the number of craftsmen in the U. S., despite the critical need and intensive search for them. This too, is a shocking fact. Actually, there was a drop of 28 percent in the number of craftsmen under age 25 between the years 1951 and 1956.

When we consider that 20 million of the new workers we will be getting between 1955 and 1965 will be under 25 years of age, we begin to realize that now is the time to start mending the flaws which are permitting large segments of our manpower to lie fallow.

Secretary of Labor James P. Mitchell, in a talk in Detroit recently, said, "If an employer wants to keep his business healthy, he is going to have to step up his on-the-job training, step up his apprenticeship, step up his efforts to fit the right worker into the right job and to give that worker the means to grow with his job. The employer is going to have to find and train his own workers. In a period of incessant technological advance and skill changes, nobody else is going to do it for him."

Planning for Tomorrow. Industry today is thinking "big" and "creatively" about the technical advances of the future. But it must think equally as big and creatively about training this manpower to build and operate these technical miracles of the future. A fundamental concept is that we must train our technical men and skilled craftsmen to adequately meet the technical demands of today if we hope to meet the technical demands of the future.

We cannot just suddenly make an electronics technician out of an unskilled worker, for example. This skill ladder has to be climbed one rung at a time and if we don't keep our men trained to handle the technical equipment of today, we're sunk in our efforts to train men to handle the technical marvels that are coming.

Maintenance at Dow. At Dow, one approach in the training of engineers in maintenance, is to assign them to the maintenance manager's office where they spend time rotating throughout the shops, getting acquainted with the problems and personnel, assisting in expediting the work, and so on. When a particular shop needs an engineer on its staff, one of the rotating engineers may then fill the job. In some cases, an engineer is hired directly into one of the shops.

Maintenance engineers and foremen participate in supervisory development programs which include supervisory induction (40 hours), work simplification program (40 hours), conference leadership, and others. These courses are on a divisional level, that is, they are not confined to any particular department but embrace all departments which desire to participate.

The Shops and Service department also has a foreman development program. A committee of 10 foremen serve as an advisory group in determining training needs, planning and developing course content. This com-

mittee works with the department heads in the Shops and Service organization and the supervisory training staff of the Education department. The guiding principle of this program is participation of the foremen in planning, developing, and administering the program.

Thus far, six 2-hour meetings have been held for 250 supervisors in 15 groups of approximately 17 men in each group. The subjects covered so far are:

1. Cooperation between Shops and Service departments and Production departments.

2. Authority and responsibility.

3. Organizing and planning work.

There are many more topics, all of which have been suggested for discussion by the foremen themselves, and they will be covered in the order preferred by the foremen. We strongly emphasize the importance of practical application of training on the job.

Applying Learning. Already follow-up action has resulted. Shop superintendents and foremen are now making practical application of the training in their own line responsibilities which is, after all the real test of the worth of any training program.

It is extremely important that you determine rather specifically the need for training your supervisors. The method you use is not as important as the fact that you do somehow determine the need. Several techniques can be used:

1. Rating performance of supervision.

2. Tests, such as how to supervise.

3. Attitude surveys.

4. Questionnaires in which the supervisor checks areas in which he feels he needs training.

The next step is to determine the course content. Remember to build your subject matter around needs expressed by supervisors.

Specific Know-How. Some other questions that need answers when planning and operating a supervisory training program are:

1. What methods and techniques will be used?

2. When and where will the training be done?

3. Who will handle the training?

4. What about presupervisory training?

5. How much will the program cost?

6. What are the results?

These questions can be intelligently answered only in the light of the specific problems of a specific plant. What might be the best answer for one plant may be entirely wrong for another.

Supervisory training deals mostly with people, not things; with personalities, not technical know-how. Every plant, even each department of that plant, has a personality of its own, made up of the personalities of the supervisors in each department. Keep this thought in mind when planning all details.

Freeing the Engineer. The engineering technician can free the engineer to devote his time to the creative work he was trained and hired to do. Engineers now devote too much time to layout and detail drafting, to laboratory test work, to fabricating models, working with building blocks and other noncreative activities. The engineering technician can do this, thus making more effective use of engineers. At Midland, Dow is studying the possible use of technicians in its Engineering department, composed of about 350 people.

In using the term "engineering technician" I also include the instrument technician, electronics technician, and so on. Industry can do much to train workers to qualify as technicians and to train technicians to qualify for many duties of the engineer.

For example, at Dow an instrument technician must satisfactorily complete two and one-half years of formal classroom instruction covering physics, electrical math, blueprint reading, piping standards, and operation and maintenance of all types of instruments. Also, automatic control, instrument laboratory work, spectroscopy course, basic electronics course, advanced electronics course, plus 6 weeks full time preparing for technician's exam.

Dow is also training journeymen and foremen to perform a great deal of work requiring electronic skill and know-how which formerly was pretty much the sole responsibility of the engineer. These journeymen and foremen are given a basic and advanced electronics courses. The electronic equipment which must be serviced is studied in a classroom-laboratory on company time.

Maintenance Technicians. Through mutual agreement with the union, Dow has recently set up a classification of maintenance technician to service production and research departments. Outstanding journeymen in a certain trade are selected and are given about 12 months full-time training to learn some of the other trades. In this way they become sort of "all-around" tradesmen and can do most all phases of maintenance in their assigned department. So far, only three men are in training and they will be assigned to research and production departments. This practice will help eliminate jurisdictional disputes and will give operating departments better maintenance service.

Be sure the training is really needed

Be Ready With Needs. When considering whether to start some sort of training program for nonsupervisory men, the first and most important question to answer is why do you need a training program? Unless you can specifically list your needs and prove them to higher management, don't even try to start.

What is meant by needs? Maybe you cannot hire highly skilled men off the street. Then you need to train them. That's the situation at Dow in Midland. Perhaps the new development in the trade, for example automation, electronics, and so forth, are so rapid your men need special instruction to maintain this equipment.

Maybe you need a standard procedure in your pipe shop for insulating overhead lines. Can your field men draw up sketches so that others can easily interpret them? There are hundreds of questions you can ask

yourself in order to pinpoint your training needs.

Consider Carefully. Let's assume your needs warrant a training program. Next consider the basic, general provisions to include, such as:

1. Selecting qualified men for training.

2. Determining standards of performance of the trainees.

3. Measuring performance of trainee against the standard of performance.

4. Job progression schedule related to training schedule.

5. Agreement of job descriptions for each classification.

6. A means of settling individual trainees problems, such as what to do when trainee does failing work.

7. A means of determining quantities of men to be trained.

8. A means of determining how, when, where training will be given.

9. Giving a clear-cut responsibility to someone for seeing the training program is carried out.

Next, negotiate a training agreement with your union concerning the points just mentioned. Generally, it's best to not put all training details into the company-union contract, but have a training agreement for each trade and consider it as a supplement to your over-all company-union contract.

Select With Care. Every man selected to enter training should be considered as a potential foreman. Because of this, and because of the sizable monetary investment you'll have in the man when he completes training, it's just good common-sense that you must have a rigid selection procedure. Good selection also means lower turnover, lower training costs, higher morale, more output—in short better service.

Perhaps by now you are thinking your company union would never stand for a rigid selection system? So many companies have successful rigid selection methods (and also have unions) that evidence seems to prove that the union is no obstacle.

If you can give some aptitude tests, you are in a position to determine what cut-off points should be used for men entering training.

If you can't sell your union on aptitude tests, try achievement tests. These are trade knowledge tests. You may want to make up your own for your own conditions. Achievement tests are definite, answers concrete and make more sense to the practical man unfamiliar with aptitude tests. However, remember achievement tests are not designed to measure aptitudes, so a combination of achievement and aptitude tests makes a good selection battery.

But don't use tests as the only selection tool. An interview by the personnel department or superintendent, a close review of past work and educational experience, strict physical requirements, personality of applicant and interest in the trade are other important considertaions.

Instructors

Now, who will do the instructing? Most training programs have one or a combination of the following people do the actual classroom teaching:

1. Supervision
2. Engineers
3. Outside educational institution
4. Vendor representatives
5. Training department personnel

The advantages of the foreman or superintendent doing the instructing are obvious, however, there are two big disadvantages:

1. It's very difficult to train most foremen or superintendents in the techniques of good instruction.

2. They usually can't take enough time from their supervisory duties to prepare properly for classes.

The same thinking applies to engineers in spite of their technical know-how. An intensive instructor training course for supervisors or engineers is a must if you expect to have top-grade instructors.

Vendors offer excellent short courses at your plant site covering maintenance and operation of equipment you purchase from them. Many companies offer this service and will tailor the course to your needs.

To get the best instruction, a full-time instructor with a degree in vocational education and some teaching experience in shop work is recommended. He could be a member of the maintenance department, training department, or personnel department. In addition, supervisors should be available to supplement instruction as the training man needs it. Thus, you have a two-man team with the training man carrying the responsibility for the instruction and calling the supervisor in for help when he feels it best to do so.

Some have said this sounds OK for a large plant, but small plants can't afford the expense. The author disagrees. A class of 10 men may cost $25 per hour in wages alone. It's just good economics to provide the most effective instruction possible for every single hour of classroom training. It's not a question of whether you can afford to have good instructors but rather that you cannot afford to have poor ones.

What and Where. What will you have in the training program? Include only the material which is necessary to know in order to do the job. Anything beyond that is training for training's sake only.

Now, where will you get the material for your courses? The best practice is to develop and prepare it within your own organization. Admittedly, this is costly and time-consuming. Therefore, when starting out, companies usually buy the course material, then gradually write their own as needs arise and as the program grows.

Another source of help comes by contacting companies who already have successful training programs in operation.

Field Work. In conducting a maintenance training program, for instance, the trainee should work in the maintenance shop and field at least 90 percent of the time. Therefore, it is important that careful planning be devoted to seeing that the trainee gets a well-rounded work experience in the shop and field. The training schedule in the shop is usually fairly easy to set up.

A rotation schedule in the field is usually much more difficult to operate than a shop-rotation schedule. Yet, a good training program must give the trainee an opportunity to perform all phases of field work required of his trade. Common practice is to rotate the trainee between all the foremen and all the journeymen. The important thing is to have a practical schedule and follow it as closely as possible. A great deal of co-operation is required to assure that the trainee's field work results in a well rounded education.

Evaluating Progress. To put teeth into your program and to hold your men to the standards you want, make a monthly evaluation of the trainee's field performance. You should also have a strong "in-training" testing

program in all three of the following areas:

1. Periodic quizzes throughout each course.

2. Final exams covering each course or covering a prescribed period of time.

3. Qualification tests on the practical phases of the work.

The main advantage of periodic quizzes is that the trainee knows where he stands and has an opportunity to improve before it's too late. When a trainee fails even one quiz, call him together with the steward and instructor and discuss his progress. Should the trainee continue to fail his quizzes after you have had several meetings with the steward present, you have a good case to remove the trainee from the trade. Dow has done this with no grievance from the union.

Examinations

Final exams should be comprehensive and cover only material the trainee has learned in the class, shop, or field. Dow requires the average of the periodic quizzes be at least 75 percent and the final exam grade be at least 75 percent. If not, the trainee is removed from the trade.

Qualification tests are usually administered by the foreman on the job site and need not be anymore time-consuming than written tests. Two key points:

1. Tests should cover those operations which occur frequently in the daily work.

2. Previous training must have been given the trainee on the skills required in the performance of the test, otherwise you may have grievance from those who fail.

What About Cost? Even when you have established the need for training, and planned the what, how, when, and where of your program, there's a little question that always pops up, "How much will all this cost?" A detailed estimated budget is the starting point, followed by a simple accounting system that can tell you how the budgeted money was actually spent.

A great mistake that many training people have made is to let their training expenses become buried and lost in a wide variety of operating accounts and factory expense items so they just can't say, "Here is what our training program costs." Put it on the table—let management take a healthy look at it—it won't be as embarrassing as you might think. Such a practice will actually help your program.

Now to the jackpot question: What are the results? How do we justify training? Does training pay off in dollars and cents? Frankly, a good answer has not been found to this last question, but the search continues. The training man is not the one to try to justify his own program. He can't. Training people have only one function; namely, service. An evaluation of the training program by those who directly use the service is the only true test of its worth.

Detailed job costs, man-hour productivity data, reduction in turnover rate, and other efficiency measurements, improved morale, less grievances, are only a few factors which may indicate the results of training.

Maintenance Training at Dow. Here again let's again use maintenance training as an example and give a brief, birds-eye view of how it works at Dow.

1. We have formal training programs in 25 trades with training agreements for each developed jointly by company and union, covering such items as:

- Selection qualifications
- Class schedules
- Shop and field training provisions
- Job progression schedules
- Grading and rating procedures
- Method of handling failures

2. Six full-time men in Maintenance Education department, besides myself, plus about 12 shop supervisors who devote part time to assisting with class instruction and administration of shop and field training.

3. We average about 150-200 men in formal training programs at any given time.

4. Classes vary in size from 1 to about 15 men. All classes are on company time. Meetings run 1 to 6 hours a week (some lab classes meetings are longer per week).

5. Maintenance education building, with several classrooms, laboratories, offices, and small auditorium.

Union's Role. Now, a few blunt words about the union's part in training. How well your union supports a maintenance training program depends more upon you than any other one factor.

The answer to those that vehemently complain that it is impossible to reason with the union, that the union obstructs their every effort to organize training, that the union refuses to co-operate, is this: How sincerely have you tried to co-operate with the union?

The company having a union is certainly not at a disadvantage as far as training is concerned. The thing that must exist, however, is mutual confidence and trust, and here again, you are the one who can do the most to build mutual confidence and trust. It took Dow 5 years to build this and it isn't easy. You've got to work at it every minute of every day.

Putting it very briefly, here is a formula: In every situation, look for the facts—search constantly for the truth and don't worry about the outcome. Let the chips fall where they may. Look for what is right, not who is right.

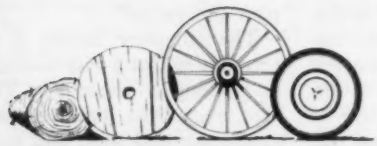
Neither management nor labor is always right. No one will disagree that as we search for the truth we will find the truth, using as our guide these Christian principles to which we all subscribe, but sometimes forget to practice, except on Sunday.

Let's apply these principles in the same manner whether we're dealing with a union steward or the plant superintendent, the janitor or the president, the apprentice or the PhD.

Originally presented before the semi-annual meeting of The American Society of Mechanical Engineers, Detroit, June, 1958.

About the Author

Ralph G. Smith is with Dow Chemical Co., Midland, Mich., where he is director of maintenance education and assistant director of labor relations. He directs training activities for the Shops & Service department, and assists the labor relations director in all of his functions. He received a B.S. degree in industrial engineering from Montana State College in 1940, and then joined American Steel & Wire Co., where he served as technical apprentice, training director, and employment director. From 1943-1946, Smith was in the U.S. Navy. He joined Dow in 1946.



How to Invent: Part 3

Prepare Yourself for Inventing

Even though most inventions come from the workings of the subconscious mind, here are some fundamentals which will improve your ability to invent

Forrest E. Gilmore
Independence, Kansas

INVENTIONS ARE frequently classified as two kinds: first, the inspired kinds and second, the deliberate kinds. These deliberate ones as were made by Edison were usually based on extensive, intelligent experiment and keen observation.

The separation of these two kinds of invention, however, is not at all sharp. Most inspired inventions were illuminations only after the inventor obtained extensive experience in the field of the invention, and after intense thought and many mental trials of numerous possible ideas. Also, in the Edisonian type of invention, inspiration played an important part in determining the experimentation and interpreting applications of knowledge obtained—therefore illumination just naturally followed. Because of the importance of the experimentation, overshadowing the inspiration, the latter usually went unnoticed.

"Avoid a negative attitude toward new things"

Inventive persons as well as would-be inventive engineers can certainly improve their ability to invent by using the fundamentals of inventing. Actually, these fundamentals are similar to those of other forms of creative thinking with the exception that they do not allow as much freedom of imagination as do painting, sculpturing, music and literature.

Those persons who invent because they find it a natural outlet for their unquenchable creative thirst, intuitively understand many of these fundamentals although they usually make no effort to classify them. However, it is highly practical for all engineers—especially supervisors and managers—to master and understand these principles and fundamentals.

Preparation for Invention

1. Be highly skillful in at least one field of industry.
2. Be skillful in more than one field—the more the better.
3. Understand the inventive process and what it means to you and to society.
4. Develop the will to invent.
5. Learn to think aside, that is, think your own thoughts from your own experiences without overly revering the conventional.
6. Avoid a negative attitude toward new things, observe them to determine why they displace the old.
7. Use conscious thought to decide the thing to be invented and to maintain direction of thoughts to the desired end; state the problem in writing.
8. Master accumulated knowledge on the subject selected.

9. Gather new facts about the subject by observing, exploring, experimenting, developing technique, skill and discrimination.
10. Develop greater curiosity by persuading yourself to take more interest in new ideas and by giving them increased attention.
11. Deliberately and purposely practice imagery, particularly in connection with intense thought while mastering accumulated knowledge and in reconstructing observations, experiments, etc.

The Incubation Period

1. Discontinue conscious work on the thing to be invented.
2. Patiently await inspiration and illumination.
3. Attempt something other than the thing to be invented with the intention to return to it within a definite time.
4. Especially when relaxing, imagine the unconscious mind working on the problem and expect illumination.
5. If illumination does not come within the set definite time, return to intense thought using knowledge accumulated; review the need and importance of the end desired and practice making every conceivable combination of the ideas available picturing each as clearly as possible in the imagination. Then, abandon conscious work as before.

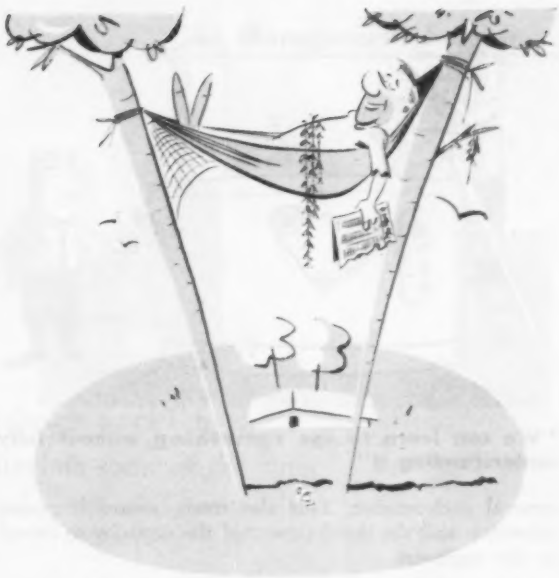
That Sudden Illumination

1. Whenever any problem under incubation or abandoned for lack of any valuable conscious or unconscious idea, suddenly comes to mind without apparent reason or because of some association of ideas such as similarities of functions, pay close attention to any ideas which may spring forth for they may be the illumination desired. Remember, though, they are not always clearly apparent and even dim ones may be good.
2. Be particularly alert for ideas on any subject under incubation that may flash into the consciousness immediately upon awakening. It appears that the subconscious frequently works best while the conscious sleeps, and the idea desired may come forth in a dream.

Checking and Revising

1. Any idea springing from the subconscious may be so unconventional and unusual that it may appear ridiculous and not the logical answer to the known problem. However, it should be consciously studied to see if it is worth consideration.
2. Ideas of inventions obtained by illumination are usually far from complete and need conscious revision and development. Sometimes the conscious revision and development depends on actual construction and trial of the invention or other experimentation.

From Many Sources. All inventions do not proceed according to these fundamentals. Many are obtained (principally by those skilled in many of the items listed under Preparation for Invention) by observing a need and then by a system of cut and trial consciously creating the answer to the need. Others are accidental inventions where the principal charactertistic of the inventor was his observation of some thing or relationship which took place where one of his senses picked it up.



"Patiently await inspiration and illumination"

Typical of this accidental type was the invention of vulcanizing of rubber by Charles Goodyear when he accidentally dropped some rubber on a hot stove and noticed that its qualities were greatly improved. However, he probably would not have noticed this, nor would it have happened at all, had he not been tremendously interested in rubber and had some with him.

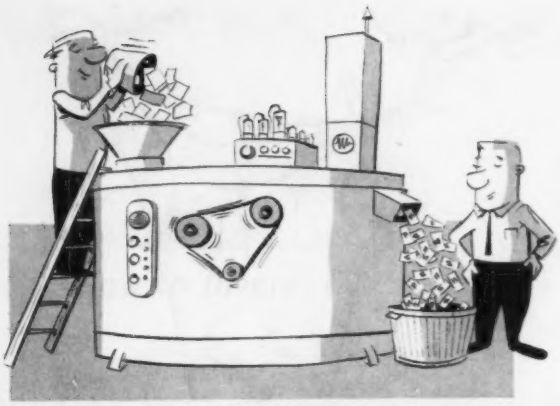
It is typical of inventions of this type that the inventor should feel he is only the agent of divine disclosure. Goodyear wrote concerning this: "It may therefore, be considered as one of those cases where the leading of the Creator providentially leads his creatures by what are termed accidents to attain those things which are not attainable by the powers of reasoning He has conferred upon them."

Other important inventions made almost entirely by accident included photography and dynamite, both made by men working in their field and being greatly interested in and observant of things that happened, that is, they were prepared to invent.

This outline of the fundamentals of invention is not submitted as completely authentic and unquestionable, but is written by an engineer experienced in invention and a student of the inventive process rather than by a psychologist from a psychological viewpoint. If I were a psychologist, my language using words not generally understood, would probably prevent my writing any useful paper for engineers on how to invent.

Old Ideas in New Fields. To invent one must think aside and to think aside one must know other fields from that in which he invents. Frequently, an engineer coming from one field of endeavor to another may see opportunities to apply to the new field ideas that are old in the first. Many times this is done in such a manner as to constitute invention.

This is one reason why the switching of engineers from one position or location to another tends to improve the



"We can learn to use something without fully understanding it"

general performance. This also tends toward increased invention and the development of the capacity to invent in the engineers.

Workings of the Subconscious. Even though most inventions come from the workings of the subconscious mind, it is the conscious mind which supplies the materials which the subconsciousness works with. These tools take the form of experiences, thoughts, feelings and knowledge. Also, it is the tensions of the conscious mind which seem to stimulate the consciousness into the inventive process.

Probably intense thought and observation produce greater impressions in the subconscious so they are easier to recall. It is said that every thought, emotion, and experience we ever had is stored in our subconscious and would be remembered if we could only recall them. This indicates that there are different levels of subconsciousness with fringe-consciousness closest to the conscious. Also, it seems that time tends to push the stored items further back into the subconscious.

However, there seems to be some connection between the magnitude of importance or emotion of the item stored and our ability to recall it. For instance, it is doubtful that any man ever forgets the first girl he ever kissed. It also probably accounts to some extent at least, for our remembering the experiences of our youth better than later ones—for in our youth these experiences seemed more important and produced greater emotion than they would have later on in our lives.

Understand the Technique. You can learn to use this technique for inventing without fully understanding it—how many users of television understand how all the electronic tubes work? Men who offer no explanation for it commonly use a technique important to invention by studying a problem and then sleeping on it overnight before reaching a decision. However, intelligent persons want to know the reasons for any techniques they use and as a result are usually more efficient in their use then they would otherwise be.

Since invention is not so much an extension of the usual as a movement beyond or a reorganization of it, frequently including new parts, the first need is to overcome the inclusion of the usual. Therefore, to invent you must yield to each impulse to apply and think of the unusual. While groping for this unusual, you may feel as one author expressed it, in a state of "imaginative muddled suspense."

Preparation for invention is mostly a conscious activity and involves mastering accumulated knowledge, gathering new facts, observing, exploring, experimenting, developing technique and skill and discrimination. The large amount of work necessary in technical preparation and the skill required in its execution is so laborious that it repels many who have inventive potentialities. However, also keep in mind that this requirement for achievement in invention is usually the principal requirement for success in engineering. This is one reason why it is advantageous for the employer of engineers to encourage invention, particularly the understanding of the fundamentals of invention. K. S. Adams, Chairman of the Board of Phillips Petroleum Company stated, "Ideas are the seeds of Phillips' progress." They might also be said to be the seeds of progress of each individual engineer.

When to Invent. The time for work is when the unconscious is most free of control of the conscious. This varies with individuals; with some it is when the mind is refreshed and rested; with others it appears to be when the conscious mind is thoroughly tired. Inventive effort should usually be reserved for periods when the mind is free of pressing routine work and outside interferences, so that a high degree of concentration may be maintained for a considerable period. Sometimes, a sleepless night is the best time.

"Sometimes a sleepless night is best"

Attention or concentration is less a gift than a habit—interest produces concentration. Curiosity which leads to keen observation is also a habit, and although it is keen in our youth it is allowed to dull with maturity. However it can be deliberately cultivated and directed. To invent one needs to be alive with it—inventors are explorers into the unknown and curiosity beckons them on. If they ignore curiosity they get nowhere.

The Role of Research. Research and activity, so important to American industry that over $5 billion a year is invested in it, is both a preparation for invention and a checking and revising operation. Since the value of research has been so widely recognized and discussed,

Continued on Page 200

Relax, You'll Live Longer

Tension causes fatigue, and fatigue causes accidents. Here are a few hints which will help alleviate some of the pressures of daily existence

TOO OFTEN, workers in offices and refineries—and people at home, too—tire themselves unnecessarily by talking too much. If we'd observe "stop" periods—periods when we did no talking—we'd find ourselves rested, both mentally and physically.

Talking too much is one of the "hazards" generated by the hustle-hustle, hurry-hurry tempo of modern-day living. The contemporary citizen's body, his mind, his emotions, are strained constantly. And the tension is telling.

Mental Exercise. "But I'm fit as a fiddle," you say. Just because you "exercise" daily by running for buses and subway trains, or by fighting the 5 p.m. traffic as you drive home. Not on your life. Though physical exercise is important, mental "exercise"—relaxation—also must be practiced.

Medical authorities assert that stress is complex. Yes, and common, too. Safety experts almost universally agree that fatigue and emotional stress also go hand-in-hand with accidents.

One safety director has observed: "The accident-prone person is a worker who over a long period of time, due to family trouble or worry, lacks that alertness on the job which is the essence of safety. Not only is he unable to give his concentrated attention to work, but even his muscular coordination may be impaired."

Fatigue Causes Accidents. Another

There are many ways to relax to prevent accumulation of small tensions.

Here are just a few suggestions.

1. **Get up 15 minutes earlier mornings than necessary and take time for an extra cup of coffee. It's an excellent way to start the day.**

2. **Take some light reading along with you as you commute to work. Or better still, close your eyes during the journey.**

3. **Disassociate your mind from work during lunch hour, whether you go for a walk, play bridge or rest at your desk.**

4. **Walk, don't run, for buses and subway trains, or if you drive, take it easy when traffic is bumper to bumper. So you are a little late, what were you going to do with those "extra" five minutes anyway?**

5. **Eat your meals leisurely, free from emotional stress.**

6. **Take things easy immediately before going to bed. Give your body a chance to slow down.**

7. **Keep irritating thoughts out of your mind at bedtime. Perhaps a glass of warm milk or a light snack will succeed in helping you sleep better.**

8. **In short — RELAX!**

safety expert said that "one of the major factors contributing to accidents is fatigue." But fatigue is not necessarily physically induced. It may be a result of emotional stress—of worry over what we consider insoluble problems.

All of us have problems—money troubles, a tedious job, conflict with fellow-workers, marriage difficulties—but letting them get out of hand has an adverse effect on our minds.

Migraine headaches, some allergies, high blood pressure, disgestive ailments—they're all frequently the outcome of emotional stress.

Try Golf or TV. Now, this is not to advocate a race devoid of emotion. All emotions are not bad. A renewed outlook on life often is a result of a pleasing emotional experience—a good game of golf (providing that a missed two-foot putt doesn't induce club hurling), a ball game or a boxing match, or simply an evening at home listening to the radio or watching television.

Unless we find a way to release our emotions, we take tension home with us. Sleeplessness, anxiety, doubt, weariness—they all accompany us home unless we master the art of relaxing.

The most difficult cross to bear is tomorrow's problem which never occurs. Top executives have their share of worries, but they've usually succeeded in rising above them. They realize that disappointment and frustration, while inevitable, often are needless and unnecessarily prolonged, and that tomorrow's problems frequently don't exist tomorrow.

Tension Breeds Illness. Ulcers, colds, asthma and many other physical conditions are aggravated by worry, by tenseness. And fatigue fits right in with that group. Persons who are balanced best are those who equalize work with honest-to-goodness play; who operate on a formula of equal parts work and rest.

To determine your physical condition, your doctor will check your temperature, your blood pressure and other factors. Your mental health depends upon your ability to relax.

There is a slogan used in highway safety which in quite appropriate here: "Slow down and live."

# #

Prepare Yourself for Inventing

Continued from Page 198

and has been directed mostly by experts in invention, I will touch on it only lightly for this is not written to teach how to conduct research such as is done in the usual research laboratory.

One's environment can to some extent be considered a research laboratory. In industry, ideas and equipment are continually being tested under actual production conditions so observations and comparisons can often be made much the same as in the research laboratory. Much of the work of the research laboratory is to determine what will happen with the product under everyday use in its everyday environment. To accomplish this the laboratory usually resorts to some speeding up process to obtain in a short time what it would take much longer to obtain under actual trial according to its intended use.

Big advantages of testing in a research laboratory rather than in actual normal use are that trained observers are giving concentrated attention to the testing; that the findings are recorded and analyzed, variations are made in the operating conditions and their effects noted and analyzed, inadequacies corrected and new ideas obtained by noting things which happen. However, the final testing is in the ultimate utility of the product or process developed disclosed by its actual use.

Most items fresh from research laboratories are far from perfect, therefore, each constitutes an improvement invention possibility. They offer opportunities for inspirational invention by suggesting through association by similarity some new way of doing something the research laboratory overlooked.

The New Idea. The intuitive idea which is usually the novel element in the invention does not as a rule constitute the whole invention. Rather, it is the key which, if it fits, unlocks the door to invention. The conscious mind tries the key, verifies whether or not it fits, and if it does enters in and deliberately completes the invention. Frequently, the conscious rejects the inventive idea and figuratively returns it to the subconscious for further consideration and new ideas. The unacceptable idea may suggest to the conscious the need for further knowledge on the subject. Also, the conscious, being too much possessed by the conventional, may reject ideas which could be refined and improved by the conscious to become practical.

Broad Road Not Easy. In closing this important article it would be pleasant to be able to write that this broad highway to invention is a smooth easy road that could be traversed leisurely at ones convenience without much effort. Such, however, is not the truth but on the other hand, neither is the progress up it too difficult for those who really want to invent.

It is never easy to become great—and a successful inventor is a great man. It takes only time and intelligent effort for most engineers to become great personalities.

You need not go all the way with this outline of how to become a successful inventor to profit by it; just pick your destination and put forth the effort accordingly. If you have about decided that the effort required is too much for you to attempt, please wait until you study the next article on Motivation of Invention. Then, if you decide that you really wish to invent, attentively read the next following article on System for Invention. It will give practical suggestions that have been successfully used on how to apply the fundamentals of invention. From it you can perhaps devise a system more suitable to your own personality and circumstances.

. In Part IV which will appear next month, the author will discuss such highly interesting and informative subjects as:

1. Motivation for inventing.

2. Why engineers should strive to be inventors.

3. The rewards which can be reaped from inventing.

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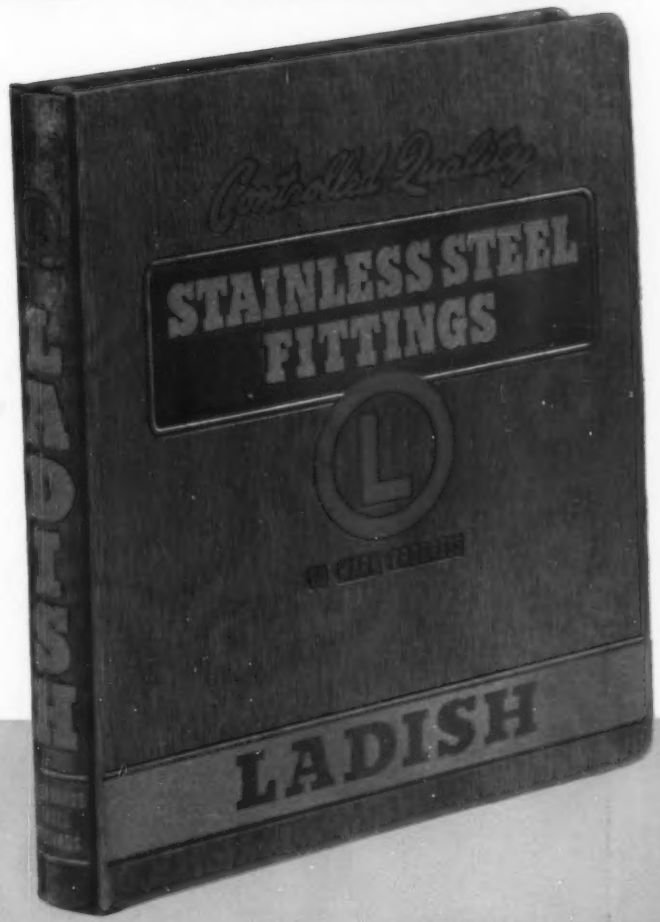

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What's Happening . . .

. . . in the Industry

Industry's Earnings Promise to Improve

Chart below shows second quarter and first half net earnings of some oil companies, 1958 vs. 1957

(All "per share" data based on number of shares of common stock outstanding June 30, 1958)

COMPANY	SECOND QUARTER $ Thousand 1958	SECOND QUARTER $ Thousand 1957	SECOND QUARTER $ Per Share 1958	SECOND QUARTER $ Per Share 1957	% Dif.	FIRST HALF $ Thousand 1958	FIRST HALF $ Thousand 1957	FIRST HALF $Per Share 1958	FIRST HALF $Per Share 1957	% Dif.
Amerada Pet.	4,299	6,901	.68	1.09	—38	9,850	15,647	1.56	2.48	—37
Anderson-Prich.	718	1,336	.37	.75	—46	1,377	2,820	.71	1.59	—51
Ark. Fuel Oil	1,018	1,689	.27	.44	—40	3,323	3,925	.87	1.03	—15
Ashland O. & R.	1,315	3,656	.16	.64	—64	3,780	8,575	.66	1.50	—56
Atlantic Ref. Co.	4,972	10,573	.52	1.13	—53	7,667	25,332	.78	2.74	—70
Champlin O. & R.	1,563	2,175	.36	.54	—28	2,865	5,342	.66	1.29	—46
Cities Service Co.	11,114	12,889	1.06	1.23	—14	24,618	36,315	2.34	3.45	—32
Clark O. & R.	63	220	.05	.16	—71	222	692	.16	.50	—68
Colorado O. & G.	265	764	.04	.21	—65	595	1,454	.10	.39	—59
Continental Oil	9,509	10,074	.48	.51	— 6	20,208	23,714	1.03	1.21	—15
*Creole Pet. Corp.	74,692	113,341	.96	1.46	—34	160,913	221,648	2.07	2.86	—27
Felmont Pet. Corp.	227	808	.06	.22	—72	942	1,668	.25	.45	—43
Getty Oil Co.	911	3,656	.05	.22	—75	7,980	12,962	.48	.80	—38
Gulf Oil Corp.	55,069	106,817	1.77	3.43	—48	115,737	201,755	3.72	6.48	—43
Hancock Oil Co.	1,526	1,874	.38	.47	—19	3,310	3,835	.87	1.01	—14
Honolulu Oil	2,187	3,773	.58	1.01	—42	5,586	7,616	1.49	2.03	—27
*Humble O. & R.						57,182	116,136	.79	1.62	—51
*Imperial Oil	9,131	16,081	.29	.52	—43	24,153	37,662	.77	1.20	—36
*International Pet.						12,900	23,300	.89	1.60	—45
La. Land & Expl.	4,861	5,831	.46	.56	—19	8,861	10,503	.99	1.17	—16
Maracaibo Oil	48	130	.10	.26	—63	139	294	.28	.60	—53
Ohio Oil Co.	6,719	9,567	.51	.73	—30	15,087	22,233	1.15	1.69	—32
Phillips Pet. Co.	15,895	25,019	.46	.72	—36	36,412	53,399	1.06	1.55	—32
Plymouth Oil Co.	650	1,886	.26	.75	—65	1,520	4,405	.61	1.76	—65
Pure Oil Co.	5,943	8,842	.69	1.03	—33	10,675	19,012	1.24	2.21	—44
Quaker State	522	588	.63	.71	—11	811	958	.98	1.16	—15
Richfield Oil	4,804	6,666	1.29	1.67	—28	10,410	13,705	2.60	3.43	—24
Shell Oil Co.	19,182	33,871	.63	1.12	—43	45,752	106,321	1.51	2.49	—57
Signal O. & G.	2,760	2,960	.63	.68	— 7	5,660	6,136	1.29	1.40	— 8
Sinclair Oil	8,399	18,546	.55	1.21	—55	24,807	44,848	1.62	2.93	—45
Skelly Oil	4,535	8,545	.78	1.48	—47	10,549	19,934	1.83	3.46	—47
Socony Mobil	28,400	59,100	.59	1.22	—52	67,500	126,800	1.40	2.62	—47
Standard, Calif.	59,325	63,224	.94	1.06	— 6	116,735	136,329	1.85	2.16	—14
Standard, Ky.	3,061	3,049	1.18	1.17	+ 1	6,301	6,332	2.42	2.43	— 1
Standard, N.J.	124,000	226,000	.82	1.11	—45	291,000	463,000	1.43	2.27	—37
Standard, Ohio	4,036	4,782	.80	.94	—16	†8,355	12,623	†1.65	2.53	—34
Sun Oil Co.	7,985	11,856	.70	1.04	—33	11,560	25,187	1.01	2.34	—54
Texas Company	68,532	78,722	1.17	1.44	—13	138,536	165,146	2.37	3.01	—16
Texas Gulf Prod.	452	1,786	.11	.44	—75	1,617	3,666	.40	.91	—56
Texas Pac. C & O.	857	1,881	.24	.52	—54	2,353	3,949	.65	1.10	—40
Tidewater Oil Co.	‡524	10,090		.67		279	21,569		1.52	—99
Union Oil, Calif.	5,462	7,400	.70	.94	—26	11,457	16,727	1.46	2.13	—31
Universal Consol.	641	946	.67	.99	—32	1,123	1,927	1.17	2.01	—42
Wilcox Oil Co.	180	281	.58	.93	—36	369	535	1.22	1.81	—31
Woodley Pet. Co.	641	899	.78	1.10	—29	1,281	1,749	1.56	2.13	—27
*Total, 41 Companies	471,322	758,872			—38	1,037,209	1,638,929			—37

* Creole, Humble, Imperial, and International Pet. are excluded from totals, being included as affiliates of Standard (N.J.).
† Excludes reported non-recurring profit from sale of properties.
‡ Deficit.

THE TREND of oil company earnings continues about the same as that of business in general. The trends currently are improving for both the petroleum industry and for business as a whole. They were very unfavorable in the first and second quarters of this year, after having turned unfavorable in the third and fourth quarters of last year.

Earnings in oil, as in other lines in the aggregate, probably will be less than a year ago during the third quarter of 1958. But the decreases should be considerably smaller than those of the first and second quarters.

The improving economic situation will aid the oil industry along with other lines of business. Demand for oil is improving as the business recovery develops. In the third quarter, it may equal the year ago trend. The demand had been off sharply in the first quarter and the beginning of the second quarter. But thereafter the decreases became smaller.

In the first and second quarters of this year, oil company profits were sharply curtailed by the shrinkage of oil demand, drastic curtailment of crude oil production and refinery runs, and serious weakening of prices of gasoline and other refined products.

Currently, however, industry operations are being stepped up, in response to better demand. Crude oil production is being gradually increased from the bottoms reached in April, May, and June. Refinery runs are being expanded proportionally. Prices of refined products have been improving since the middle of the year. Both producers and refiners will benefit from these trends.

However, production volumes and product prices still are lower than a year ago. The industry also has had further increases in costs of steel prod-

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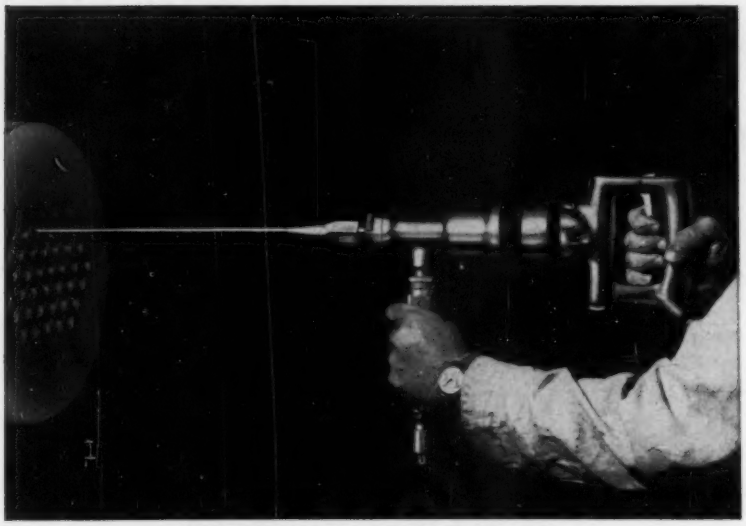

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What's Happening. . .

ucts and other items. Consequently, it is unlikely that oil company earnings in the third quarter of this year can equal those of the like period last year.

Oil industry earnings in the second quarter of 1958 were about 38 percent lower than in the like period of 1957. This is indicated by the table herewith. Forty-one oil companies earned $471,322,000 in this year's second quarter, compared with $758,872,000 in last year's, a decrease of 37.9 percent.

In the first quarter of this year, the industry's earnings were off 33 percent from a year earlier. The earnings had been down about 13 percent in the fourth quarter of 1957 and off about 7 percent in the third quarter of 1957.

NPA Panel Says Oil Will Lead in Spacecraft Fuels

Four top-drawer experts on fuels and propellants for aircraft, missiles and spacecraft agreed generally that the petroleum industry is going to be key factor in these fields for a long time to come. They were participating in a panel discussion of fuels and propellants at the 56th annual meeting of the National Petroleum Association in Atlantic City, Sept. 11. Two represented industry, and the others spoke for the military.

One man said the "petroleum industry, with its wealth of technical manpower and with its tremendous storehouse of knowledge in chemistry and chemical engineering is particularly well-fitted for research and development work in the propellant field."

The panel members were Paul M. Terlizzi, of Stauffer Chemical Co., Washington, D. C.; John F. Tormey, Astrodyne, Inc., McGregor, Texas; W. E. Sheehan, Office of the Assistant Secretary of Defense for Research and Engineering, Washington, D. C.; and Ben F. Wilkes, aeronautical research administrator, U. S. Air Force, Washington, D. C.

Terlizzi discussed the role of petroleum as an energy source for missiles. He predicted that new chemical compounds would be based on petroleum products, but that the latter would be altered considerably to meet specifications calling for greater speeds, higher altitudes, and more heat energy per pound and volume.

He said the day will soon be here when a passenger airliner can be zero launched, and, using a ram jet power plant, streak to its destination at speeds of above 2,000 miles per hour, and at a 100,000-foot altitude. But, he said, "what the future power plants will use as fuel will depend upon the ingenuity and effort put forth by such companies as are represented here today."

Tormey credited the petroleum industry with having played a significant part already in the development of propellants. He said that "without the advice and assistance of the men in and from the petroleum industry, the solid propellant industry would never have enjoyed the amazing spurt it has seen in the last five years."

Tormey also noted that there are technical inadequacies and industrial oppor-

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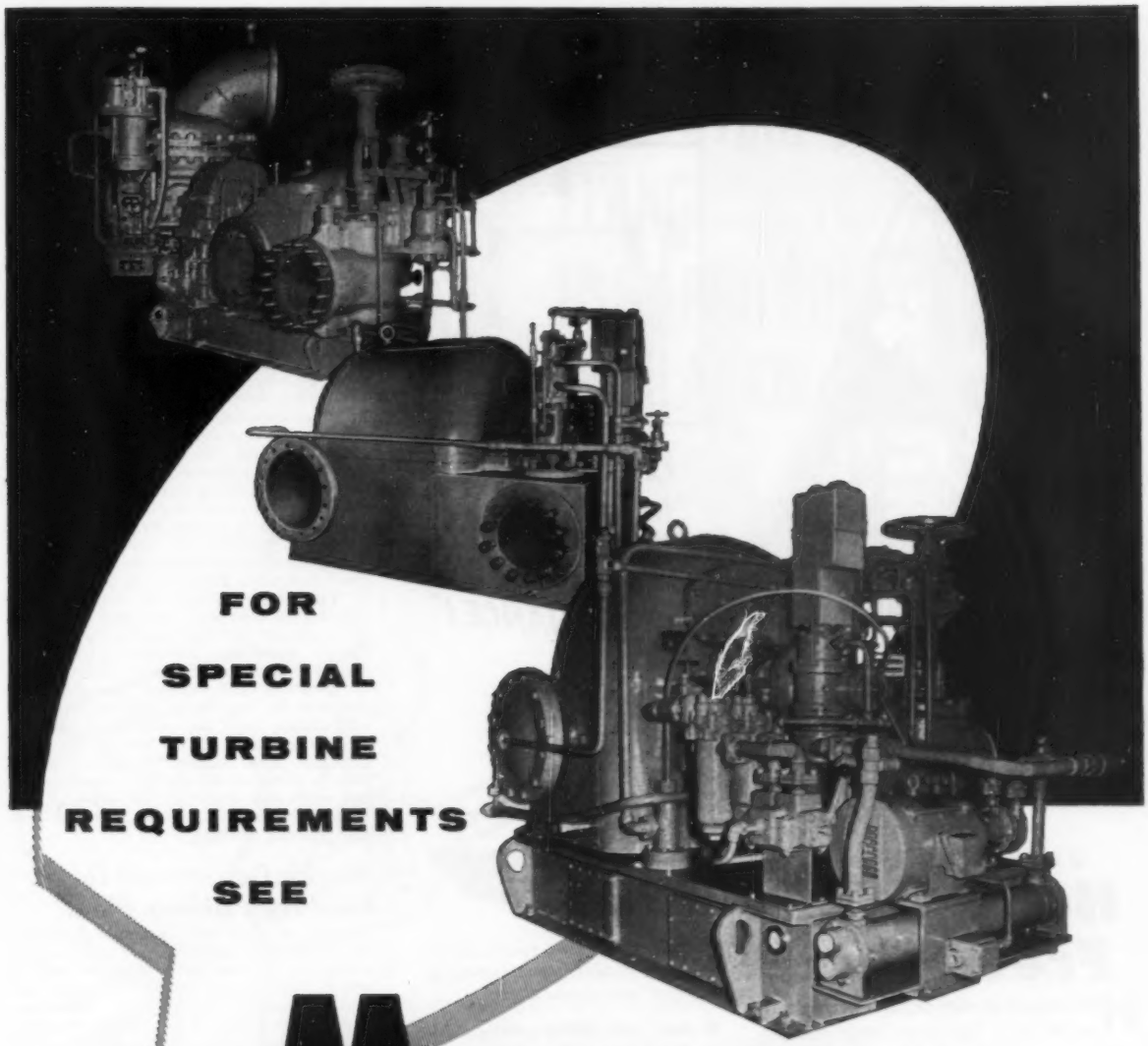

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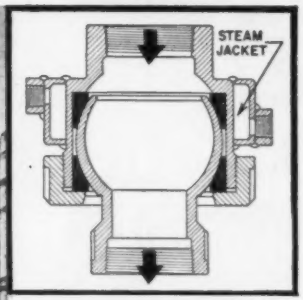

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FEATURES

COMPLETE LINE — Barco Steam Jacketed Flexible Ball Joints are now offered in 2", 3", 4" and 6" sizes.

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tunities in the rocket and spacecraft propellant field, and that an alert, aggressive petroleum industry, willing to take a chance, can fill these gaps. He emphasized that the need for petroleum's highly specialized skills in research and development is real and urgent.

From the military point of view, Sheehan reported that the peak of propellant energy has just about been reached with currently available chemicals. This means, he said, that entirely new compounds must be synthesized before higher energy propellants can be experimentally compounded for evaluation.

Sheehan said that oil's wealth of technical manpower and its tremendous storehouse of knowledge are particularly suited for research and development work in the propellant field. He expressed confidence that the oil industry "can perform any task that it is called upon to do, and will be furnishing assistance in this field as long as there is a need for rocket power."

Wilkes provided the group with detailed descriptions of various fuels for aircraft and space missiles, and added:

"I'm afraid we have reached the point I indicated two years ago, that we hoped we never would. That is, we are approaching the status of a different fuel for each weapon system (or transport system).

"Whatever the problem, we will have the best for maximum performance. We will always trust the petroleum industry to lead us as it always has in the past. Likewise, now too for the chemical industry, since chemicals are coming into use more and more for all aircraft, missiles and spacecraft, except for transport and training aircraft."

Interior Department to Build New Helium Plant

Funds totaling approximately $12 million have been approved by congress to enable the Interior Department to build a new helium plant in the Keyes natural gas field, Cimarron County, Okla., according to Acting Secretary of the Interior Hatfield Chilson. The plant would become the fifth operated by the government.

The department signed a contract last April with the Colorado Interstate Gas Co. for exclusive rights to extract helium from gas produced by the company in the Keyes field. This field, about 15 miles from Boise City, Okla., is the best commercial helium-bearing natural gas source discovered since 1943.

Specifications have been drawn up for a plant capable of processing a maximum of 70 million cubic feet of natural gas daily—which would mean a yearly output of from 200 to 290 million cubic feet of helium.

The current annual consumption of 330 million cubic feet is 70 times the amount consumed 20 years ago, Chilson noted, and the four helium plants operated by the Bureau of Mines cannot keep pace with growing requirements. Although adding the Keyes plant to the helium production line could boost total output to approximately 600 million cubic feet a year, the department believes that even this amount would fall short of the estimated demand soon after 1960.

However, an ambitious helium-conservation program for which the department recently requested enabling legislation would permit recovery of some three billion cubic feet a year of helium which now is lost when natural gas containing it is

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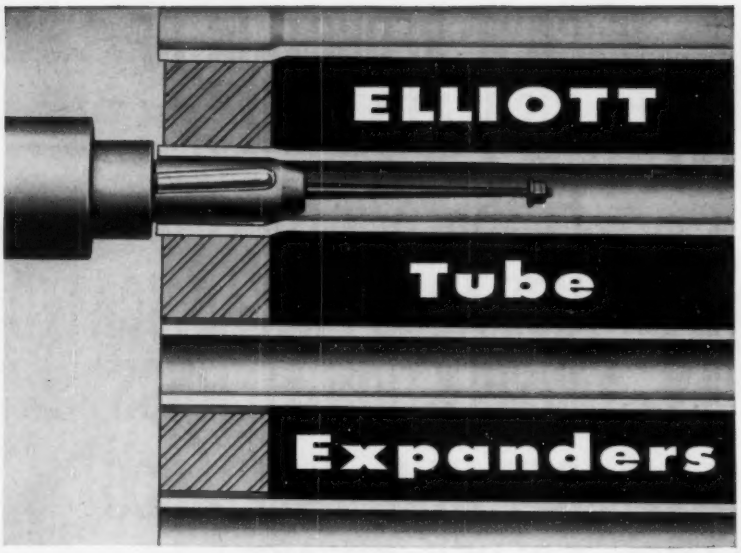

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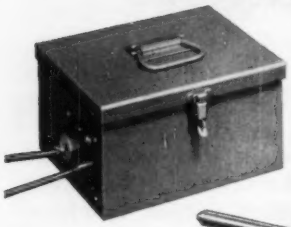
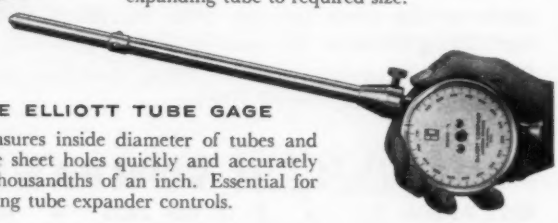


A *torque limiting device* takes guesswork out of tube rolling. Designed for use with any standard tapping motor, it's compact, easy to operate, and reduces chance of tube failure and tube sheet distortion. *Voltage Balancer* eliminates need for voltage regulator, *Torque Control Knob* assures expanding tube to required size.



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burned as fuel. Under the proposed program, private industry would be encouraged to build plants that would extract helium from natural gas before it goes to fuel markets. This helium would be purchased by the government and stored for future use in the Cliffside field near Amarillo, Texas.

The new Keyes plant will contribute significantly to the helium-conservation program, according to Chilson, who explained that the Keyes gas, containing about two percent helium, now goes direct to fuel markets. Both the helium content and the reserves of helium in the natural-gas reserve at Keyes are considered above average, he pointed out.

If production from the completed Keyes plant should create a temporary surplus of helium, the excess would be stored in the Cliffside field until needed, Chilson said.

New Imports Program Proposed by Carson

A new system of allocating crude oil and unfinished oil imports on the basis of refinery runs rather than historical importing patterns has been proposed by Matthew V. Carson, Jr., administrator of the Voluntary Oil Import Program. "It is my hope," said Carson, "that the new proposal, with any necessary revisions, will provide a basis on which the petroleum industry can continue efficiently and effectively to contribute to the security of the Nation with full assurance that long-range planning will not be disrupted by sudden changes in permissible import operations."

Under Carson's proposal, the over-all level of allowable crude oil imports would be computed on the basis of total demand—both domestic and export—rather than on the rate of domestic crude oil production now used. The proposed over-all level would be 10.1 percent of annual total demand, as estimated by the Bureau of Mines.

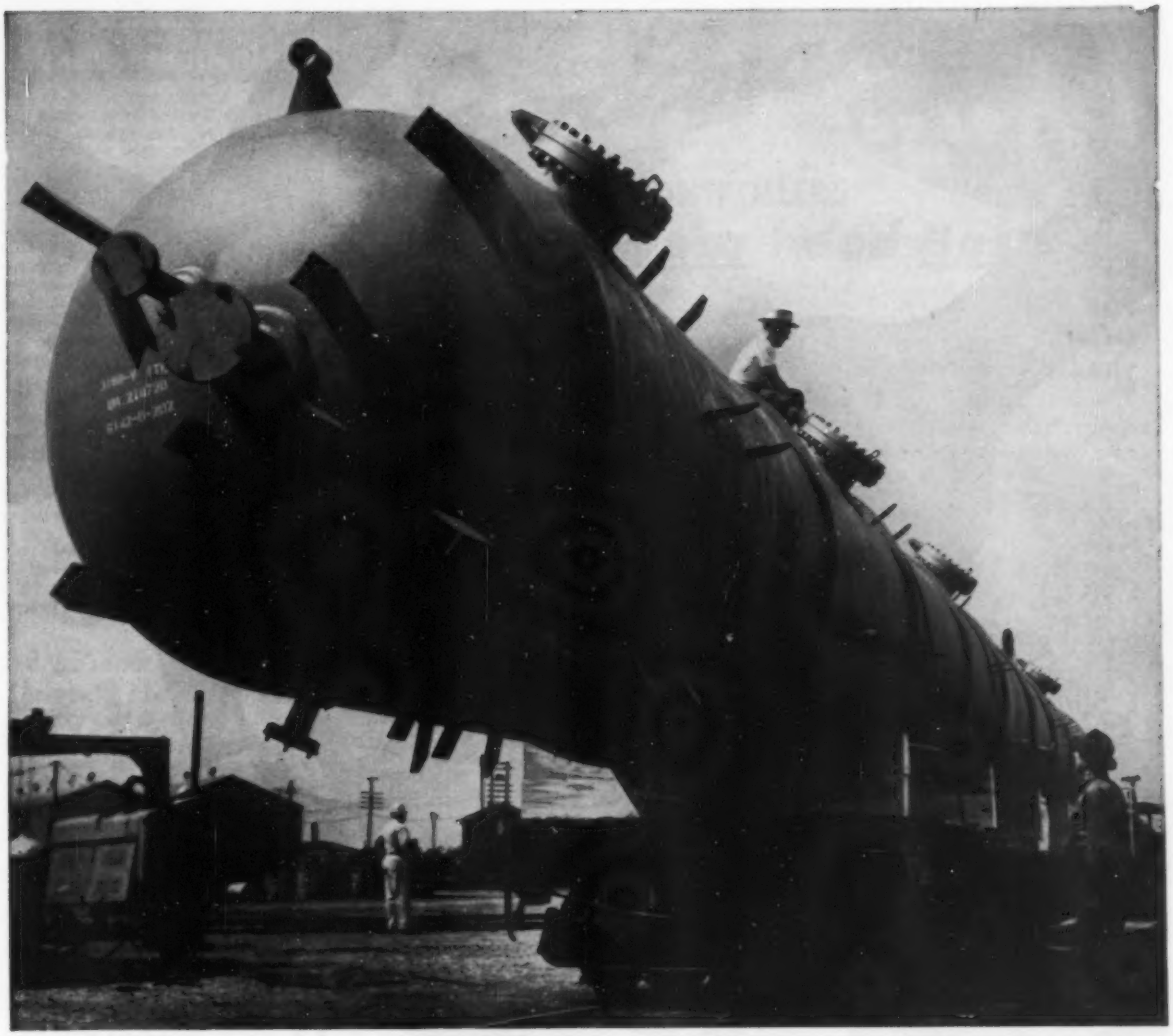
Should the plan be adopted, a transition period of one year would allow authorized importers to adjust their operations. Prior to January 1, 1959, current allocations on crude and unfinished oils would remain in effect, and no action would be taken on requests for increased or initial allocations.

Standard of Indiana Reveals Missile Program

Standard Oil Co. (Ind.) is engaged in research and development of specialized solid propellant fuels for U. S. Air Force missiles. A current project is development of a solid fuel for use in an auxiliary power unit for the air-to-air Falcon missile. The Hughes Aircraft Co., Culver City, Calif., is the prime contractor for the project.

The company's scientists began work on solid fuels research in 1951 at the Whiting, Ind., laboratories. Work was concentrated in 1954 at new laboratories at Seymour, Ind. Until now, information on the scope of the project has been withheld because of the specialized and classified nature of the work.

Standards' solid fuels have several advantages over some others. One characteristic is their use of a thermo-plastic binder which permits molding the fuel at moder-



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

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ate temperatures into a desired shape or size. It is easier and results in less time to manufacture such a tailored fuel charge than is possible with most other fuels. They also have a specially developed non-corrosive, clean-burning characteristic that is desirable for the light-weight APU systems needed in rockets or missiles for operating accessory equipment. These novel fuels markedly contrast to the solid or liquid fuels actually used to propel a rocket, he added.

The new facilities at Seymour are being constructed under an Air Force contract and are expected to be occupied this fall. They will provide additional space for laboratories, machine shop and processing work. Construction work is being performed by Dunlap & Co.

The first laboratories erected by Standard in 1954 at Seymour were authorized in an Air Force contract for solid fuels research and development work in cooperation with the Wright Air Development Center, Air Research and Development Command. A pilot plant was added in the first expansion project at Seymour in 1955.

ASME and ARS to Have Separate National Meeting

The American Society of Mechanical Engineers and the American Rocket Society have announced that in the future their major national meetings will be held independently of each other. Both 1958 Annual Meetings will be held in New York but on different days.

The announcement, issued jointly by the two societies, indicated that separate meetings will be held because of expanding size of the technical sessions and limited hotel space available. A second reason assigned was the "increasingly independent status of the rocketry and the concurrent growth of ARS from a small group to one of substantial stature in the technical field."

The 1958 ASME Annual Meeting will be held at the Hotels Statler-Hilton and Sheraton McAlpin, New York, November 30 through December 5; the 1958 ARS Annual Meeting will be quartered at the Statler-Hilton two weeks earlier, November 17-21. In 1959, the ASME Annual Meeting will be held in Atlantic City while that of ARS will be held in Washington, D. C.

Plans for Iran's Growth Include New Plastic Plant

Russell E. McClure, former president of International City Managers' Association and city manager of Corpus Christi, Texas, since 1953, will become general manager of a program of economic development being undertaken in Iran by Development and Resources Corp. of New York, on behalf of the Iranian Government's Plan Organization. The company was engaged by Iran in 1956 to develop agriculture and industry in the southwestern Khuzestan region, along the lines of the Tennessee Valley Authority program in the U. S.

In Iran, McClure will head a 500-man staff, including 35 American and European engineering, agricultural and managerial specialists, engaged in the execution of several projects to develop the vast re-

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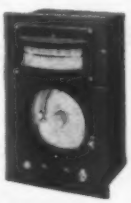

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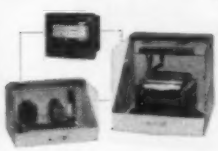

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sources of the Khuzestan region. Among them are:

- A polyvinyl chloride plastics plant, which will be the first petrochemical industry based on the rich Iranian oil and gas fields in the Khuzestan region, scheduled for completion in 1961.
- A natural gas pipeline from the Agha Jari oil field to Ahwaz, where the plastics plant will be built, to provide the plant and future petrochemical industries with raw material for manufacturing.

The firm's program in Iran moved into the construction stage in 1957, after a little more than a year of survey and planning work.

Underground Stocks of Liquefied Gas Increased

Underground stocks of liquefied petroleum gases on July 31, totaled 663 million gallons, an increase of 90 million gallons during the month, according to the Bureau of Mines, U. S. Department of the Interior.

Of the total, 546 million gallons were concentrated in Alabama, Mississippi, Louisiana, Texas, and New Mexico, and the rest was distributed through New York, Michigan, Illinois, Kansas, Oklahoma, and Montana.

Underground stocks of propane totaled 376 million gallons, an increase of 89 million gallons; butane 261 million gallons, a decrease of 4 million gallons; and butane-propane 26 million gallons, an increase of 5 million gallons.

Oil Shale Retorting Economical Says DRI

Economic studies conducted by the Denver Research Institute, University of Denver, reportedly show that the basic costs for retorting Colorado shale oil in a commercial-size plant would run as low as $.452 per barrel, utilizing the process the Institute has under development for The Oil Shale Corp.

"These costs," the Institute said in its summary report based on two years of research and development work, "are considerably less than any costs previously reported for retorting Colorado oil shale by any other process."

In information previously made public, the Institute reported that this process makes possible the production of shale oil at costs that would make it competitive with crude petroleum.

For the purpose of its current economic study, the Institute selected a hypothetical plant processing 19,200 tons of shale daily and utilizing shale containing 25 gallons of shale oil per ton of rock. Such a plant, it was explained, is the minimum size that could efficiently handle the output from a shale mine using the low-cost mining methods developed by the U. S. Bureau of Mines. Production from such a plant would be 11,400 bpd of shale oil and 427 bpd of liquefied petroleum gas.

Figuring depreciation over a 20-year period, the Institute gave these estimates as to total costs, daily charges, and unit costs:

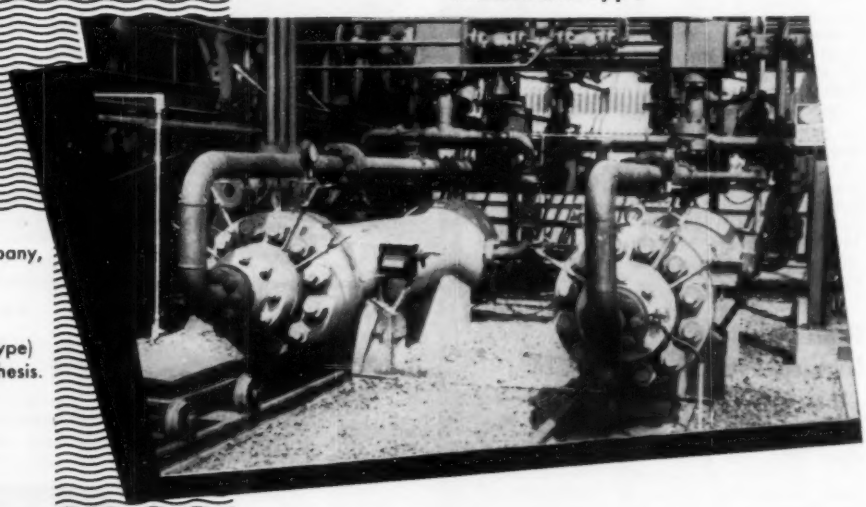
	Crushing	Retorting	Coking	LPG Recovery	Total
Total Capital Required	$2,823,000	$19,010,200	$117,000	$1,042,450	$22,992,650
Daily Capital Charges	462	3,182	18	170	3,832
Daily Operating Charges	1,161	2,553	80	376	4,170
Daily By Product Credit	.....	—580	.....	—1,077	—1,657
Total Daily Charges	$ 1,623	$ 5,155	$ 98	$ —531	$ 6,345
Total Unit Cost					
Cents per ton of shale	8.5	26.9	0.5	—2.7	33.2
Cents per bbl. of oil	14.3	45.2	0.86	—4.7	55.7

(**Note:** Minus costs indicate a credit. These include excess by-product power generated by the retorting plant — for mining, crushing and sale — and by-product LPG recovered for sale.)

In computing these costs of retorting oil shale by The Oil Shale Corporation's process, the Institute excluded interest on capital invested in the plant, interest on construction capital, profit, federal income taxes, cost of shale land and credit for depletion allowance.

"These items were excluded in order to permit interested companies to apply their particular individual financing practices for each of these items to the basic cost data," the Institute said. "The interest, income taxes and profit charges, of course, are partially

GHH H.P. Centrifugal Gas Circulators, Maulwurf-type



Spencer Chemical Company, Vicksburg, Mississippi, employs two GHH centrifugal gas circulators (Maulwurf-type) in their ammonia synthesis. These units have operated without trouble since February, 1954.

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Filters

Basic filter parts include: the outside container, the bed of filter medium and the distribution and collection systems to provide a uniform flow through all parts of the bed. Flow rates average 2 to 3 gallons per minute per sq. ft. of bed area.

Filter beds are cleaned periodically by reversing the flow and increasing it to about 10 to 20 gpm per sq. ft. (backwashing). This lifts and swirls the sand, loosening the dirt and flushing it to waste.

Rotary surface washers with high-velocity water jets may be used to help break up the layer of dirt on top of the bed.

After backwashing, the first water through the filter (rinse water) also picks up some dirt and is run to waste.

A "multiport valve" replaces 5 individual valves and reduces the number of valve manipulations for cleaning a filter from 10 to 3. It also indicates the cycle in progress and ensures proper sequence. Operation can be made completely automatic with hydraulically- or motor-operated valves controlled by meters, timers and float switches.

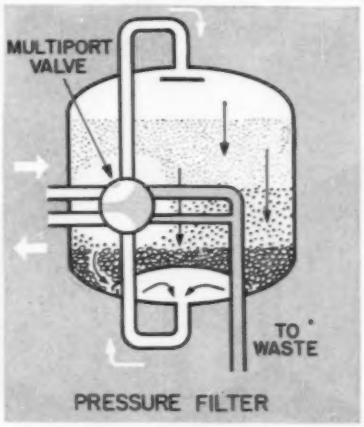
SAND FILTERS for removing dirt, precipitates, suspended solids

Sand filters simply "strain" the water as it flows downward through the filter bed. It is probably the oldest and most widely used method of water treatment.

Gravity filters. Practically all large public water-supply plants include a series of gravity filters made of concrete for permanence and low maintenance cost. Sizes run up to 400 or 500 sq. ft. for each filter.

Chief difference among concrete gravity filters is the method of water collection under the filter bed. The false bottom system provides uniform collection but requires about 2 ft. extra filter height and is highest in cost. Header-lateral collection systems of steel pipe are lowest in cost but do not provide perfectly uniform collection and can corrode. There are also patented systems such as Permutit's *Monocrete®* system which uses collapsible forms for casting lateral ducts in the concrete itself. *Monocrete* ducts are oversize for uniform collection and are corrosion-free since no metal is used. The cost is less than for false-bottom construction.

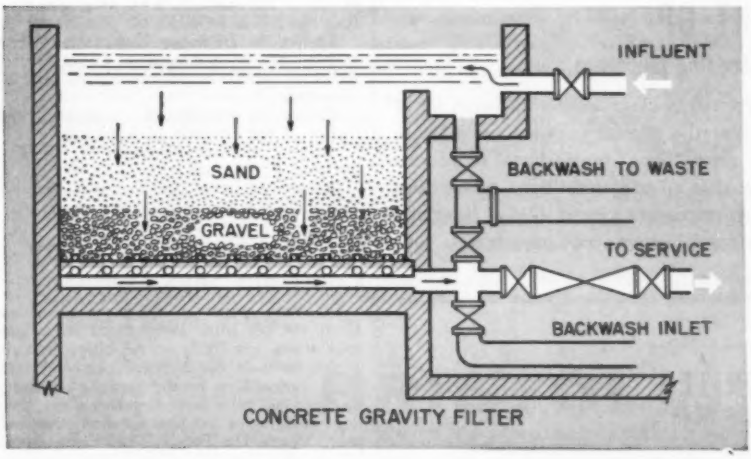
Steel-tank gravity filters cost less than concrete in small and medium sizes and are generally used in industrial plants. Wood-tank filters have low maintenance cost, but they are not practical for large sizes and not as attractive as painted metal. They are now used primarily where there is a metal shortage.



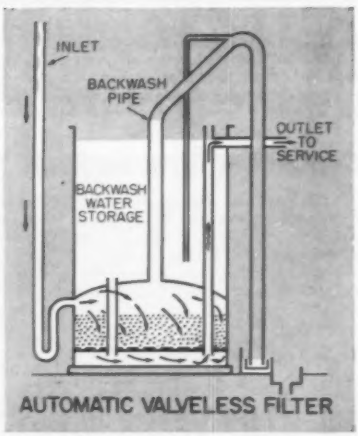
PRESSURE FILTER

Pressure filters deliver an effluent under pressure, usually under 100 psi, to eliminate repumping. Since no water depth is required over the bed to provide pressure, these filters are smaller and lower in cost than gravity filters of the same capacity.

Vertical pressure filters are available to 12 ft. diam. with approx. 113 sq. ft. of bed area. Horizontal pressure filters provide large filter-bed areas, up to 200 sq. ft., at lowest tank cost but may not maintain as uniform bed conditions as vertical type.



CONCRETE GRAVITY FILTER



AUTOMATIC VALVELESS FILTER

Automatic Valveless Filters (gravity type) are a new Permutit development. They greatly reduce filter cost because they use no valves or flow controllers. They provide completely automatic, foolproof self-operation yet actually cost less than conventional manually-operated gravity filters. Sizes up to 12' diam. available.

When the suspended matter removed by the filter bed causes the pressure loss to reach a predetermined figure, backwashing starts automatically. At end of backwash, flow reverses automatically, and the backwash storage compartment is then filled with a brief rinse plus filtered water. Filtered water then passes to service through a separate outlet.

FILTER MEDIA for removing oil, bad tastes, odors, etc.

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Calcium Carbonate (Neutralite) raises the pH of low-pH, corrosive water at the same time that it filters.

Manganese zeolite oxidizes and removes moderate amounts of iron and manganese, also hydrogen sulphide, chief cause of "rotten egg" odor and sulphur taste. It is regenerated with potassium permanganate.

For information on filters or other water-conditioning equipment, write: The Permutit Company, Dept. PR-10, 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

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For more data on advertised products, use Readers' Service Cards, last page.

offset by any depletion credit obtained." (A recent Internal Revenue Service ruling has indicated that the present 15 percent mining depletion allowance is applicable to oil shale.)

September Octanes Rise

Gasoline on sale at service stations in September increased to national weighted averages of 98.6 octane number for premium and 91.4 octane number for regular, according to the latest monthly survey of antiknock quality by Ethyl Corp.

National Aluminate Corp. To Acquire Howe-Baker, Inc.

Howe-Baker Engineers, Inc., is being acquired by National Aluminate Corp.

In addition to Visco Products Co., Houston, National Aluminate now has two other divisions servng the oil industry —the Catalyst dvision and the Industrial division. The acquisition will enable Nalco to render new services to the oil industry, and make available to Howe-Baker the research facilities of Nalco.

Howe-Baker will operate under its own name as a Nalco subsidiary, and operate under its present management. Company headquarters have been moved to Tyler, Texas.

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Bold Political Statement By Gulf's Gray Gets Support

Initial reaction to the bold political statement made by Archie D. Gray, senior vice president in Gulf Oil Co.'s house organ recently, has been generally good, although some newspaper caricaturists have labeled it with the usual cynical picture of oil trying to dominate the U.S. government. "Whether we want to be there or not, Gulf, and every other American corporation is in politics, up to its ears. We must either start swimming, or drown." Gulf intends to conduct a continuous survey of the official behavior of elected officials, bearing on attendance, voting on key issues, speeches, and committee activity, with primary emphasis on members of Congress. Gulf would keep its employees and stockholders advised accordingly.

Gulf's example and action should be successful, if followed in the right way. Businessmen have stayed out of politics often for fear of offending customers. But if information given to employees and stockholders is conscientiously slanted toward election of good public servants and elimination of demagogues, regardless of party affiliation, customers can have no valid complaint.

Some contend the main weakness in Gray's statement is that it infers partiality to Republicans, since much emphasis is put on labor's political activity. Much labor slush fund money has gone to elect so-called "liberal" northern Democrats. Gulf's inference is that we need good public office-holders, regardless of party affiliation. If Congress is made up of good men, it will enact needed good legislation, regardless of its party makeup.

API Streamlines Schedule

API's forthcoming meeting has been streamlined even more than it was last year when one full day was lopped off. This year, all group and general sessions will be completed by noon on Wednesday, leaving only board, committee, and subcommittee meetings on the agenda for Wednesday afternoon.

Except for division of finance and accounting, all divisions will hold only one group session in Chicago. The Fundamental Research Program, which has been sponsoring a group session annually, will have instead a series of project gatherings.

The preliminary program for the Division of Refining is as follows:

TUESDAY, NOVEMBER 12, Refining Session, Conrad-Hilton—Grand Ball Room. Presiding, H. W. Ferguson, vice president for refining, API; vice president, Humble Oil & Refining Co., Houston.

Report on Divisions Nominating Committee—W. W. Scheumann, Cities Service Research and Development Co., N. Y., Chairman.

Election of members of the general committee of the Division of Refining.

Address by Vice President H. W. Ferguson.

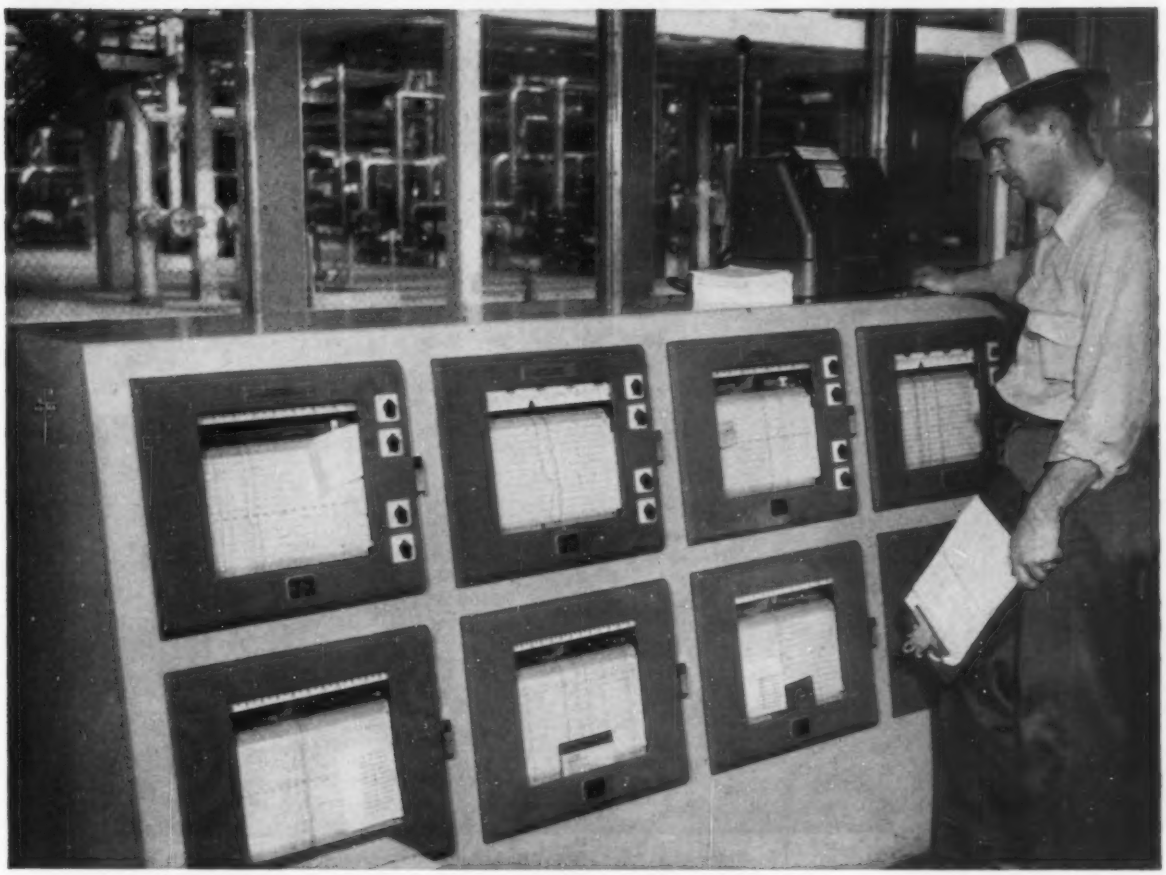
Committee meetings for the Refining Division are scheduled for Nov. 6-13.

Du Pont Employes Safety Conscious Says Company

Du Pont employes are three times less likely to get hurt away from work and four times less likely to be killed in auto accidents than the average person in the U. S., according to the company's safety statisticians, who were reporting on accident records for the first six months of this year. "Since Du Pont's 90,000 employes

"MILLION-DOLLAR" CONTROL SYSTEM

spots trends with Bristol recorders



THESE MULTIPLE-CHANNEL BRISTOL TREND RECORDERS—one of several such groups—can spot troubles before they start at the Delaware Refinery of Tidewater Oil Company. All of the self-balancing bridge and potentiometer instruments in this modern plant are Bristol's. Instrument system designed and installed by Panellit Inc., Skokie, Illinois.

Designed to nip trouble in the bud, the "million-dollar" control system at the Delaware Refinery of Tidewater Oil Company features the latest analogue-to-digital scanning and logging techniques—and several batteries of patchboard-connected Bristol Dynamaster* trend recorders that can display almost any variable measured or controlled in the entire plant.

This uniquely flexible system lets the operator, in any of the plant's nine control rooms, record only those variables that need close, continuous checking. He simply plugs the recorders into the desired circuits at the patchboard and gets continuous records as needed.

Bristol Dynamaster electronic instruments are ideal as general-purpose recorders like these, and for special applications, too. The Dynamaster's high accuracy, outstanding flexibility, extremely broad range of accessory equipment, easy adaptability and exclusive features like No-Batt Continuous Standardization make it a consistent favorite among instrument men everywhere.

Find out how Bristol instruments—the most complete line of full-sized and miniature electronic and pneumatic instruments on the market—can help solve your difficult problems in recording, indication or automatic control. Write: The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

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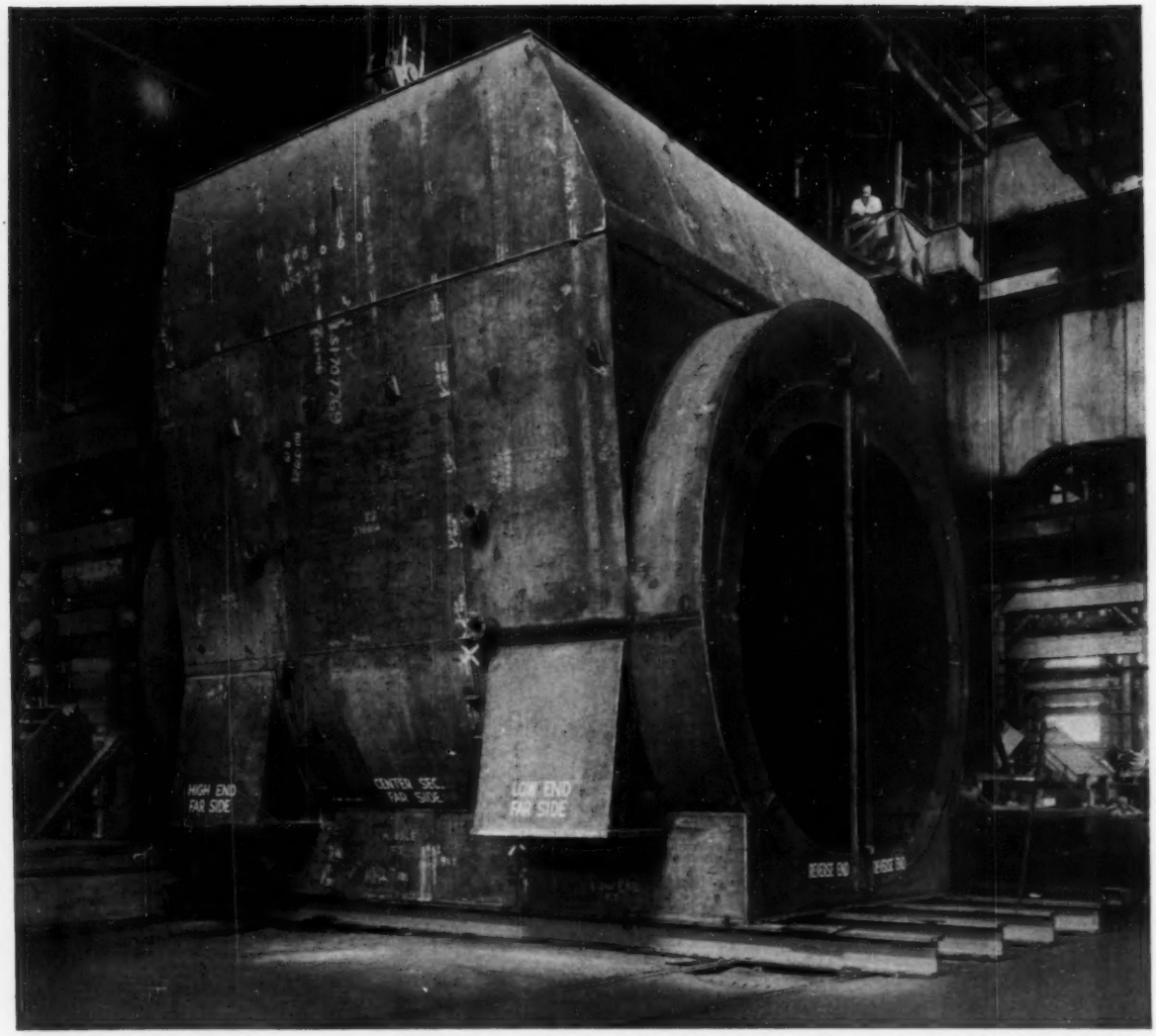

Operator of overhead crane (top, right) and workmen on shop floor are dwarfed by the enormousness of this surface condenser casing fabricated by B-L-H's Eddystone Division.

No welding job too big for vast B-L-H facilities

No welding job—not even the biggest pressure vessels—is too large for the facilities of Baldwin-Lima-Hamilton's Eddystone Division. The fabricating shop covers 15 acres and is divided into 13 bays, each 80 ft. wide and 600 ft. long.

Sheer size does not, of course, even begin to tell the whole story. From automatic tracer flame cutters to individual hand welders, we have a tool for every conceivable operation. And there is no reason for you to spend money transporting formed parts to Eddystone for welding—or completed weldments to some other shop for machining. We can handle every phase of the job—from design right through to delivery. No wonder so many companies bring the big ones to B-L-H.

Our illustrated Weldment Bulletin 7001 will give you an excellent idea of our vast facilities. You should have it in your files. For a copy, write to B-L-H Corporation, Philadelphia 42, Pa.

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form a cross section of the public, and are no safer than any other group, it is believed that these records are no accident, but reflect the payoff of the Du Pont safety program," says the company. "The employes are so safety-conscious on the job that a lot of it sticks with them when they go home.

—Changing Times—

El Dorado, Kan., greeted American Petrofina with an all day celebration Sept. 25 as the newly integrated oil company officially began operations in the city and state for the first time. **Petrofina recently purchased Petro-Atlas Corp. and its subsidiary, El Dorado Refining Co.**

Fifteen technical sessions, at which 100 papers will be presented, are scheduled for **AIChE's 51st annual meeting in Cincinnati, Dec. 7-10 at Netherlands Plaza Hotel.** The 1959 officers will be announced and three awards will be presented to leaders in the profession.

Oil industry plans to spend $245 million on research in 1958 according to President M. J. Rathbone, Standard Oil Co. (N.J.). Last year, when 25,000 people were engaged in oil research, **industry's research outlay was $231 million.**

Sohio's Industrial Relations department will combine with company's management development and organization planning activities **to form an Employe Relations department.**

Enjay Co. has entered plastics field, and has concluded four-year sales agreement with Spencer Chemical Co. Enjay will market polypropylene and supply Spencer with it for resale. Company's **supply will come from new Humble Oil & Refining Co. plant.**

D-X Sunray Oil Co. has cut crude runs 10,000 bpd at its two Oklahoma refineries. Company president said this is an 11 percent cut from July, 1958 level. He added that **"a study of industry-wide inventories shows that reductions in mid-continent and mid-western crude runs is imperative and must be immediate.** Modest price increases in the area have caused refiners to have false sense of security."

Gulf Eastern Oil Co.'s London office has made two organizational changes. Supply department, which is concerned with coordination of product supply in Eastern Hemisphere, will be taken over by, and carried as unit of, Manufacturing department.

On August 26 **Standard of Indiana's Whiting Research lab terminated 14,330,000 man-hours without a lost-time accident.** Record, which began in 1952, was ended by a minor accident.

Consolidation of **public affairs activities of the petroleum industry in Pennsylvania,** previously conducted by several groups, has been **completed in an organization to be known as Associated Petroleum Industries Committee of Pennsylvania.** Headquarters will be in Harrisburg.

ERRATUM

The September PETROLEUM REFINER **reported that Standard Oil Co. (Ind.) had received the National Safety Council's Award of Merit** for accumulating a million man-hours of operation without a lost time accident. **Actually, it was Standard Oil Co. of California, not Indiana, who set the record** at its El Segundo refinery. Our thanks to Standard of California for calling this to our attention.

MEETINGS CALENDAR

OCT.	
19–21	National Assn. of Oil Equipment Jobbers, Annual Convention and Trade Show, Hotel Adolphus, Dallas.
20–21	Instrument Society of America, National Rubber and Plastics Instrumentation Symposium, Akron, Ohio, Site Unreported.
20–22	American Oil Chemists Society, Fall Meeting, Sherman Hotel, Chicago.
20–22	Society of Automotive Engineers, National Transportation Meeting, Lord Biltmore Hotel, Baltimore.
20–24	National Assn. of Corrosion Engineers, Annual Conference and Exhibition of South Central Region, Roosevelt Hotel, New Orleans.
20–24	The 46th National Safety Congress and Exposition, Conrad Hilton Hotel, Chicago.
21	American Society of Safety Engineers, Annual Meeting, Conrad Hilton Hotel, Chicago.
22–24	American Petroleum Institute, Meeting of Committee on Disposal of Refinery Wastes, Statler-Hilton Hotel, Dallas.
22–24	Society of Automotive Engineers, National Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.
23–24	Western Petroleum Refiners Assn., Session on Refinery Technology and Industrial Relations Meeting, Rufus Garrett Hotel, El Dorado, Ark.
27–28	International Petroleum Assn. of America, Annual Meeting, Statler-Hilton Hotel, Dallas.
27–31	American Society for Metals, National Metal Exposition & Congress, Cleveland Public Auditorium, Cleveland.
31	Natural Gasoline Assn. of America, Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
NOV.	
4– 5	International Management Society, 2nd Annual Seminar on Executive Techniques for Industrial Engineering, Hotel Sherman, Chicago.
5– 6	Society of Automotive Engineers, National Fuels and Lubricants Meeting, The Mayo Hotel, Tulsa.
5– 7	Society of Rheology, Annual Meeting, Franklin Institute, Philadelphia.
6–7	Louisiana Polytechnic Institute, 7th Annual Instrumentation Conference, On Campus, Ruston, La.
8–13	ACS Rubber Chemistry division, ASME Rubber & Plastics division, ASTM Committee D-11, International Rubber Conference, Shoreham and Sheraton Park Hotels, Washington, D.C.
10–13	American Petroleum Institute, 38th Annual Meeting, Conrad-Hilton, Palmer House & Congress Hotels, Chicago.
12–13	Chemical Market Research Association, Fall Meeting, Minneapolis & St. Paul, Minn.
17–19	National Association of Corrosion Engineers, 8th Western Region Meeting, Statler Hotel, Los Angeles.
17–19	National Fire Protection Association, Fall Conference, Penn-Sheraton Hotel, Pittsburgh.
18–20	American Petroleum Institute, 9th National Conference on Standards, Hotel Roosevelt, New York City.
20–21	Commercial Chemical Development Assn., with National Agricultural Chemicals Assn., Lord Baltimore Hotel, Baltimore, and Beltsville Research Center, USDA, Beltsville, Md.
21	National Gasoline Association of American, Panhandle Plains Regional Meeting, Herring Hotel, Amarillo.
30–Dec. 5	American Society of Mechanical Engineers, Annual Meeting, Statler & Sheraton-McAlpin Hotels, New York City.
DEC.	
3– 5	American Petroleum Institute, Oil Information Committee Meeting, Waldorf-Astoria Hotel, New York.
4– 5	Industrial Engineering Conference, Sponsored by Illinois Institute of Technology, Chicago.
7–11	American Institute of Chemical Engineers, Annual Meeting, Netherland Plaza Hotel, Cincinnati.
JAN. 1959	
12–14	National Association of Corrosion Engineers, Eastern Regional Meeting, Montreal Quebec, Site Unreported.
23	National Gasoline Association of America, Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City.
28–29	Midwest Welding Conference, Sponsored by Armour Research Foundation and Chicago Section of American Welding Society, at Illinois Tech, Chicago.
FEB.	
2– 6	American Society for Testing Materials, Committee Week, William Penn Hotel, Pittsburgh.
11–13	National Association of Corrosion Engineers, Western Regional Meeting, Calgary, Alberta, Site Unreported.
15–19	American Institute of Mining Engineers, Annual Meeting, Sir Francis Drake Hotel, San Francisco.
27	National Gasoline Association of America, Permian Basin Regional Meeting, Schorbaur Hotel, Midland, Texas.
MAR.	
1– 5	American Society of Mechanical Engineers, Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati.
8–12	American Society of Mechanical Engineers, Aviation Conference, Statler Hotel, Los Angeles.
9–11	Midwest Gas Association, Annual Meeting, Hotel Fort Des Moines, Des Moines.
16–20	National Association of Corrosion Engineers, 1959 Corrosion Show and 15th Annual Conference, Sherman Hotel, Chicago.
16–20	American Society for Metals, et al, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
APRIL	
5–10	Instrument Society of America, Nuclear Congress, Cleveland Auditorium, Cleveland, Ohio.
6– 7	Instrument Society of America, 2nd Annual Symposium on Chemical & Petroleum Instrumentation, Site Unreported, St. Louis.
13–17	The 29th Annual Safety Convention & Exposition, Hotel Statler, New York.
15–17	National Petroleum Association, Semi-annual Meeting, Hotel Cleveland, Cleveland.
19–23	American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Shamrock-Hilton Hotel, Houston.
22–24	National Gasoline Association of America, 38th Annual Convention, Baker and Adolpus Hotels, Dallas.

What's Happening . . .

. . . *Among Men* in the Industry

Fred C. Koch has been elected to membership on the board of directors of Universal Oil Products Co. He is chairman of the board of Koch Engineering Co., Inc., Wichita, and a director of the First National Bank of Wichita. He has been in the oil refining industry in various capacities since 1924. These include vice president of Winkler-Koch Engineering Co., Inc.; and president of Koch Oil Corp., Rock Island Oil & Refining Co., and Wood River Oil & Refining Co.

Koch

E. G. Warren, Jr., has been promoted to senior electrical engineer, Technical division, at Humble Oil & Refining Co.'s Baytown refinery. He is responsible for estimating costs and developing complete electrical designs for major additions and modifications to process units, power facilities, and remote control systems. Warren has B.S. degree in electrical engineering from Louisiana Polytechnic Institute and a M.S. degree from Georgia Institute of Technology.

M. F. Granville has been named general manager of The Texas Co.'s Petrochemical department at New York. He was formerly superintendent of the Chemicals division at Texaco's largest refinery, at Port Arthur, Texas.

Granville has been with Texaco since 1939. He received a B.S. degree from the University of Texas in 1937, and a M.S. degree in chemical engineering from M.I.T. in 1939.

Arthur J. Palmer has been named an engineering associate for Esso Research and Engineering Co. He will be located in the Esso Engineering branch office, The Hague, Netherlands.

Palmer joined Esso Engineering in 1951 after doing engineering development work for a firm in Philadelphia. Until his new assignment, he was in the Design Engineering division.

Edwin F. Morello has been named a group leader at the Whiting Research laboratories, Standard Oil Co. (Ind.). He has been active in research on solid propellants for aircraft and missiles, and will continue to direct a phase of this work.

Frederick H. Gilchrest has been named technical assistant to the director of product development, Solvay Process division, Allied Chemical Corp. A graduate of Lehigh University, he holds a B.S. degree in chemical engineering. He also received a M.B.A. degree from Harvard.

John Johnston, Jr., supervisor of E. I. duPont de Nemours & Co.'s Engineering Service division consultation group, has been elected president-elect-secretary of the Instrument Society of America. He will assume the duties of president in September 1959. He is a veteran ISA man, having participated in the early meetings that culminated in ISA's formation. A mechanical engineering graduate of Drexel Institute of Technology in 1953, Johnston is a professional engineer in Delaware.

The present president is **Henry C. Frost,** who was installed at the society's annual meeting September 17. He is assistant chief engineer with Corn Products Refining Co. of Chicago, and is a graduate of the University of Toledo.

Gerald McGrew has been named vice president of Cities Service Oil Co. He was manager of the company's Crude Oil Supply division. He joined the company in 1940 as a valuation engineer, and later served in the company's Engineering division and the Purchasing and Stores department.

Manager of crude oil supply since 1955, McGrew is a graduate of the University of Kansas with a B.S. degree in chemical engineering.

Dr. Hendrik J. Morsman has joined the Athens, Greece office of George Armistead and Co. as assistant manager. He was formerly process superintendent for Great Northern Oil Co., St. Paul, Minn., and previously served with Shell Oil Co. in the Caribbean in South America. He will be concerned with administrative and economic features of the refinery operation.

Morsman

Dr. Ralph M. Hill has been appointed a senior research associate by Esso Research and Engineering Co. He is head of chemicals information in the firm's Technical Information division, and prior to that was in the firm's Chemicals Research division.

Dr. Hill has a B.S. degree in chemistry from Battle Creek College, a M.S. degree in chemistry from Georgia Institute of Technology, and a Ph.D. degree in chemistry from the University of Wisconsin.

Frederick H. Gilchrest has been appointed technical assistant to the director of product development, Solvay Process division, Allied Chemical Corp. A graduate of Lehigh University, he holds a B.S. degree in chemical engineering, and a M.S. degree in business administration from Harvard Business School.

Carl A. Setterstrom has joined Sun Oil Co.'s Research and Development division as assistant director of commercial development. For the past three years he has been special projects manager for Chas. Pfizer & Co., Inc. In 1936 he graduated cum laude with a B.S. degree in chemical engineering from the Polytechnic Institute of Brooklyn. He also has done graduate work at Columbia University.

Setterstrom

He is a member of ACS and was one of the founders of the group's division of chemical marketing and economics and a past director of the New York section.

Dr. Marcel Gaschke, of The M. W. Kellogg Co., has been appointed a research chemist in the company's Jersey City Research and Development laboratory. He holds a degree in chemistry from the University of Paris and M.S. and Ph.D. degrees from the University of Chicago. Before coming to Kellogg, Dr. Gaschke was engaged in fundamental research at Rayonier Inc.

W. R. Sorenson has been appointed superintendent of the Chemicals division at The Texas Co.'s Port Arthur works. He was formerly assistant superintendent at the Eagle Point Works, Westville, N. J.

Sorenson received a B.S. degree in chemical engineering from Kansas University in 1937. He joined Texaco's Port Arthur refinery that same year, and since then has held assignments at various Texaco installations. He had been assistant superintendent at Eagle Point Works since 1955.

Howard C. Pyle, Los Angeles, has been elected president of AIME for a year beginning in Feb., 1959. He is president of Monterey Oil Co.

Others elected include **Dr. Joseph L. Gillson,** chief geologist of E. I. du Pont de Nemours & Co., to become president-elect, pointing to the AIME presidency in 1960 following Pyle's term; **Thomas C. Frick,** The Atlantic Refining Co., vice president; **Dr. Walter R. Hibbard, Jr.,** General Electric Co., now president of The Metallurgical Society of AIME, to become vice president; **Elmer A. Jones,** St. Joseph Lead Co., vice president; and **John C. Kinnear, Jr.,** Kennecott Copper Co., vice president.

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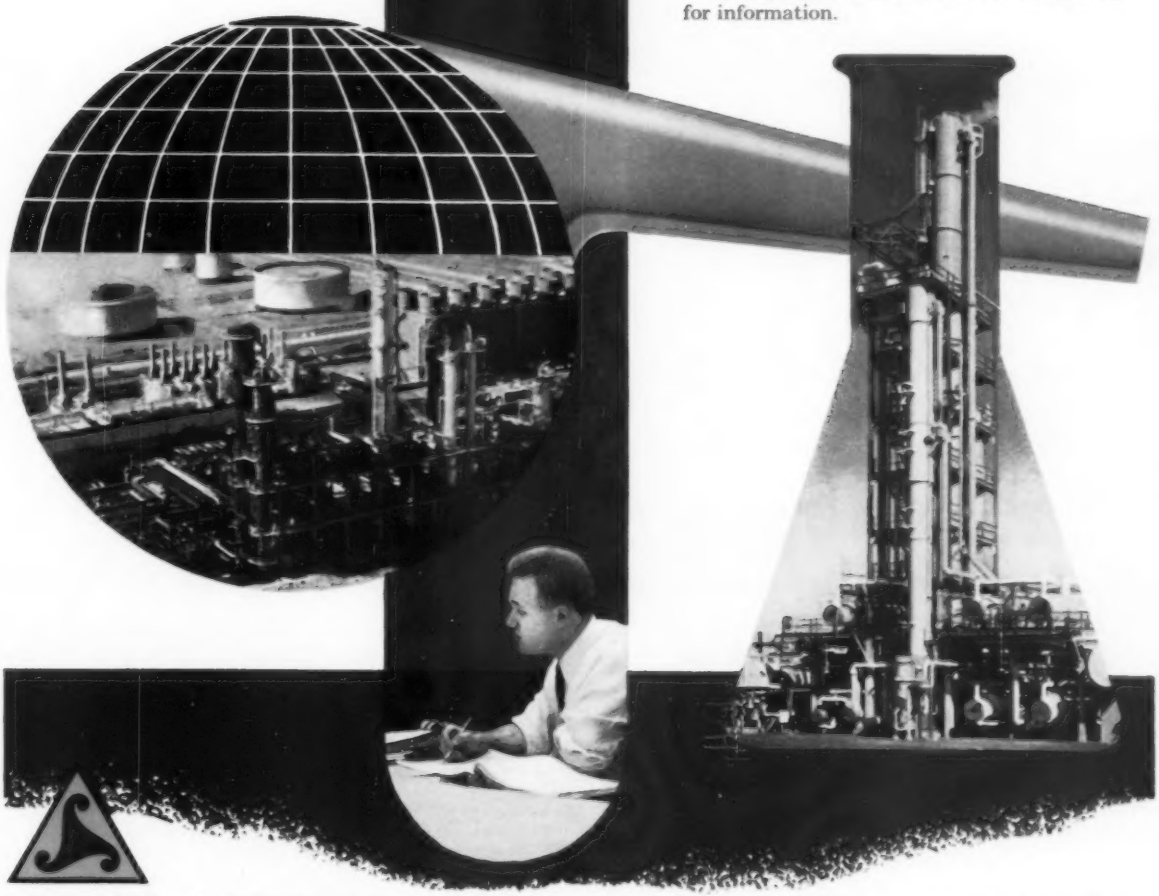

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MEMO TO MEN
ON THE WAY UP

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PETROLEUM REFINER

Men in the Industry . . .

New directors named for three years, will be:

John S. Bell, Humble Oil & Refining Co., who is president-elect 1959 of the Society of Petroleum Engineers of AIME; **Dr. John C. Chipman,** Massachusetts Institute of Technology, who will become president of the Metallurgical Society in February; **Dr. Arthur B. Cummins,** Johns-Manville Research Center; **Dr. Carleton C. Long,** St. Joseph Lead Co., who will become vice president of The Metallurgical Society in February, pointing to its presidency in 1960; and **Jerome W. Woomer,** Pittsburgh consultant, who in February also will become president of the Society of Mining Engineers.

M. F. Granville has been named general manager of The Texas Co.'s Petrochemical department at New York. He was formerly superintendent of the Chemicals division at Texaco's Port Arthur refinery.

Granville has been with Texaco since 1939. He received a B.S. degree from the University of Texas in 1937, and a M.S. degree in chemical engineering from M.I.T. in 1939.

Howard S. Bean, chief of the Capacity, Density, and Fluid Meters section of the National Bureau of Standards retired recently. He is the author or co-author of more than 30 papers and publications dealing with fluid measurement and metering, particularly with orifice meters for measuring large volumes of gas. He is a member of the AGA, ASME, the Washington Academy of Sciences, and Sigma Xi.

D. C. Clark, Jr., has been promoted to staff engineer in the Technical division, Humble Oil & Refining Co.'s Baytown refinery. He will work in process design of refinery units. Clark has a B.S. degree in chemical engineering from Texas A & M College and a M.S. degree from the University of Michigan.

Max L. Passante has been appointed director of foreign operations for Lion Oil Co. division of Monsanto Chemical Co. He has a Ph.D. degree in geology from the University of Rome, Italy. Since 1938, he has been doing oil and gas exploratory work in Europe, South America and the U. S.

Lyle E. Schaffer has succeeded **Wilfred P. Cavanaugh** as division purchasing agent in the Construction and Equipment division, Purchasing department, Chicago general office, of Standard Oil Co. (Ind.).

Howard F. Bjork has joined Weinrich & Associates, Chemical Engineers. He was formerly with Sharples Chemicals, Inc. and Pennsalt Chemicals Corp. He served successively as chemical engineer, chief chemical engineer, production manager, plant manager, vice president in charge of manufacturing of Sharples and director of manufacturing and general manager of the Sharples division of Pennsalt. Most recently he was president of the Althouse Chemical Co.

Orland M. Reiff, a chemist, and **Paul B. Weisz,** a physicist, have been promoted to senior research associates by Socony Mobil Oil Co., Inc. Dr. Reiff started with the company as a research chemist in 1926, and became a research associate in 1944,

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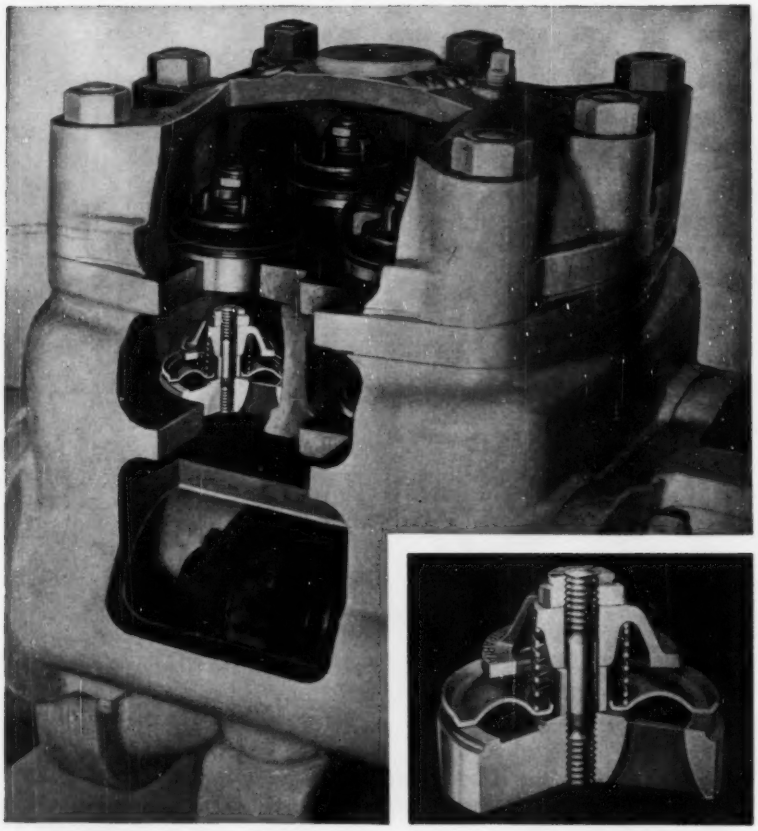

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Men in the Industry . . .

a position he held until his new appointment.

Weisz joined Socony Mobil as a research associate in the Paulsboro laboratory in 1946. He had previously been a research assistant in the Institute for Cosmic Ray Research at the University of Berlin, a research physicist at the Bartol Research Foundation, and a project engineer with the Office of Scientific Research and Development at the M.I.T. Radiation Laboratory.

W. B. Cleveland has been elected to Creole Petroleum Corp.'s board of directors. He has been associated for 20 years with Creole.

Henry R. Menapace has joined Whiting Research laboratories, Standard Oil Co. (Ind.), to conduct research on the chemistry of petroleum fuels. He obtained a Ph.D. degree in chemistry at Ohio State University, where he also completed his undergraduate training.

Dr. Melvin C. Hobson has been appointed a research chemist by The M. W. Kellogg Co. Formerly with the General Electric Co., he will engage in basic research. Dr. Hobson holds a B.S. degree in chemistry from the Virginia Polytechnic Institute and M.S. and Ph.D. degrees in chemistry from the University of Pennsylvania.

Oscar John Dorwin, formerly vice president and general counsel, The Texas Co., was elected senior vice president, and will continue as general counsel. **Marion J. Epley, Jr.,** assistant to the chairman, was elected a vice president of the company.

Kerryn King, formerly general manager of the Industrial and Public Relations department, was elected vice president in charge of that department.

E. R. Estus of Cities Service Oil Co., Bartlesville, who has been on sick leave, has requested relief from duties as superintendent of safety and supervisory training. He will continue part-time as a consultant.

W. L. Ambrose will administer safety and supervisory training activities.

William R. Kelly, assistant division manager of Sinclair Refining Co., Fort Worth, has been promoted to manager of the company's Rocky Mountain division with headquarters in Denver. Kelly succeeds **D. R. McCallum** who has been moved to Fort Worth as assistant to **O. F. Birkett,** manager of the Southwestern division.

Louis E. Ott has joined Whiting Research laboratories, Standard Oil Co. (Ind.), to conduct research on petroleum asphalts. Dr. Ott obtained his B.S., M.S. and Ph.D. degrees in chemistry at Kansas State College.

Thomas E. Fitzgerald and Glenn E. Wynn, have been advanced to senior vice president posts by D-X Sunray Oil Co. Wynn recently was named president of Suntide Refining Co. and Fitzgerald was named executive vice president of Suntide, a Sunray Mid-Continent Oil Co. affiliate.

As senior vice presidents, Wynn and

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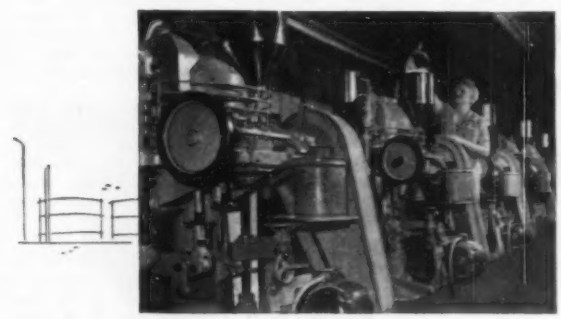
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming — Dehydrogenation — Alkylation
Cyclization — Dehydration — Hydrogenation
Oxidation — Desulphurization — Hydro treating
Chlorination



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THE HARSHAW CHEMICAL CO.

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For more data on advertised products, use Readers' Service Cards, last page.

Here is the capacity range of Purolator lube grease filters...

ELEMENT SPACING	MICRON EQUIVALENT	CAPACITIES IN GPM VISCOSITIES IN SSU WATER 30	100	300	700	1000	3000
.001	25	53	31	18	12	10	6
.0015	37.5	76	44	26	17	14	8
.002	50	97	56	33	21	18	11
.003	75	133	77	46	29	25	14
.005	125	190	110	65	42	36	21
.007	175	194	112	66	43	37	21
.008	200	207	120	71	46	39	23
.010	250	230	133	79	51	44	25
.015	375	230	133	79	51	44	25
.020	500	200	116	68	44	38	21

NOTE: Flow rates are based on clean fluid at 1 PSI initial pressure drop. To approximate the flow of 1 PSI in SCFM for air, nitrogen, or similar gases, multiply the flow in GPM at 100 SSU by 4.

... and here are the advantages:

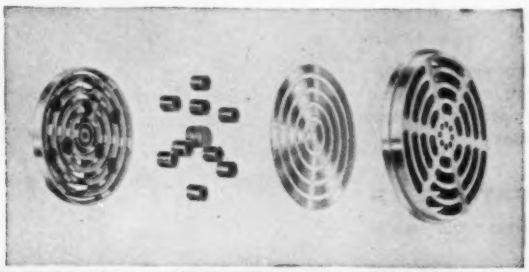
- It's easier to change the Purolator element between batches. Handles are attached to the specially constructed screw-on case.
- Cleaning the element is fast, easy and thorough; simply rotate the element, manually or mechanically, against a fixed knife blade.
- Filtration is dependable and accurate because this filter uses Purolator's Metal Edge principle, a tight durable coil of precisely spaced metal ribbon.
- The filter is designed specifically for batch filtration of greases.

For more specific information contact Purolator Products, Inc.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.
RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable ... ductile ... resist fracture, high temperatures and corrosion ... withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J.H.H. VOSS VALVES REG. U.S. PAT. OFF.
J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

Men in the Industry . . .

Fitzgerald will each be available for speical management assignments. Both men have long executive records in the D-X organization. Fitzgerald joined the company in 1917 as an assistant cost clerk at the Tulsa refinery and became vice president in 1949. Wynn, starting with the Tulsa plant as a test engineer in 1924, was named vice president in 1947.

Clarence M. Alsys has joined the Whiting Research laboratories of Standard Oil Co. (Ind.). He will conduct research on improved processes for producing chemicals from petroleum. He has B.S. degrees in chemistry and chemical engineering. He is a member of the ACS and AIChE.

Louis A. Salvador has joined Whiting Research laboratories, Standard Oil Co. (Ind.), to conduct research on improved processes for producing chemicals from petroleum. Salvador obtained his B.S. and M.S. degrees in chemical engineering at Carnegie Institute of Technology.

Dr. H. G. Schutze has been promoted to research associate in Humble Oil & Refining Co.'s Research and Development division at Baytown. He is in charge of the research specialist group engaged in polymer research. Dr. Schutze has B.S. and M.S. degrees in chemical engineering and a Ph.D. degree in organic chemistry from The University of Texas.

Dr. L. M. Dvoracek has been promoted to Senior Design Engineer at Union Oil Co. of Calif.'s Research Center, Brea, Calif.

Dr. W. F. Faragher has been named assistant to the president, The Research Institute of Temple University. For the past 27 years he has been a close associate of Eugene J. Houdry, developer of the Houdry catalytic cracking process and other catalytic petroleum processes, as director of research, and later as chemical advisor in the development of oxidation catalysts for the prevention of air pollution and the recovery of heat.

Dallas Jennings, of Esso Standard Oil Co., has retired. For the last 13 of his 42 years with Esso Standard, he was manager of the Lubricants and Specialties division. For 16 years he was head of the Products group in the Manufacturing department. Jennings attended the University of Virginia and joined Esso, as a chemist, at the old Standard Inspection laboratory, Bayonne, N. J. He moved to the New York offices of the lab when he was named its assistant director in 1942.

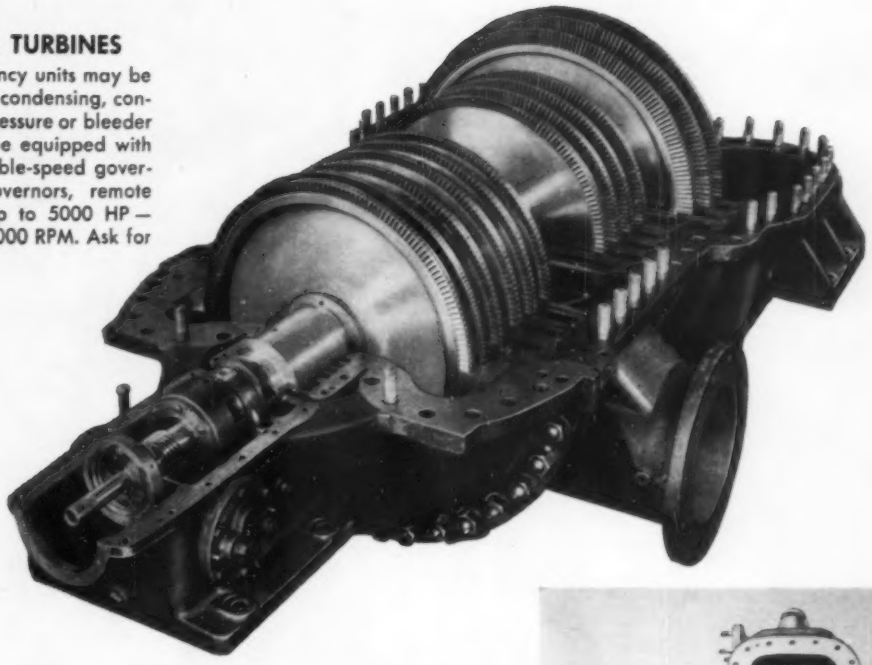
Sumner Sollitt Co. of Chicago, Engineers and Constructors, has named **R. N. Mullin** director of petroleum industry activities. He retired September 1 as division general manager of Gulf Oil Corp. where he had charge of marketing operations in 11 western states.

H. L. Cornish has joined Humble Oil & Refining Co.'s Technical division at Baytown. Other new men are **L. W. Leggett, Jr., E. H. Lovering** and **E. P. Sims. W. J. Walstead** has transferred to that division from Humble's Production department, and **R. G. Henry** and **M. H. Love** have completed military service and returned to Technical division.

They are all chemical engineers. Cornish holds B.S. and M.S. degrees from the

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

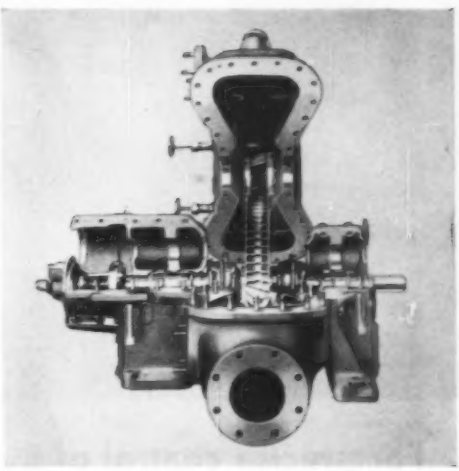
There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

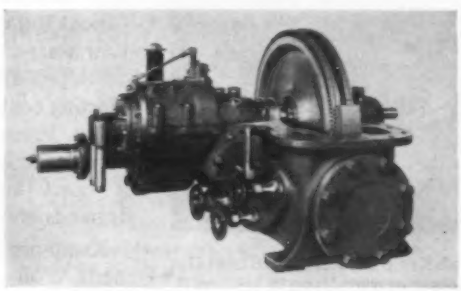
TERRY

TT-1209



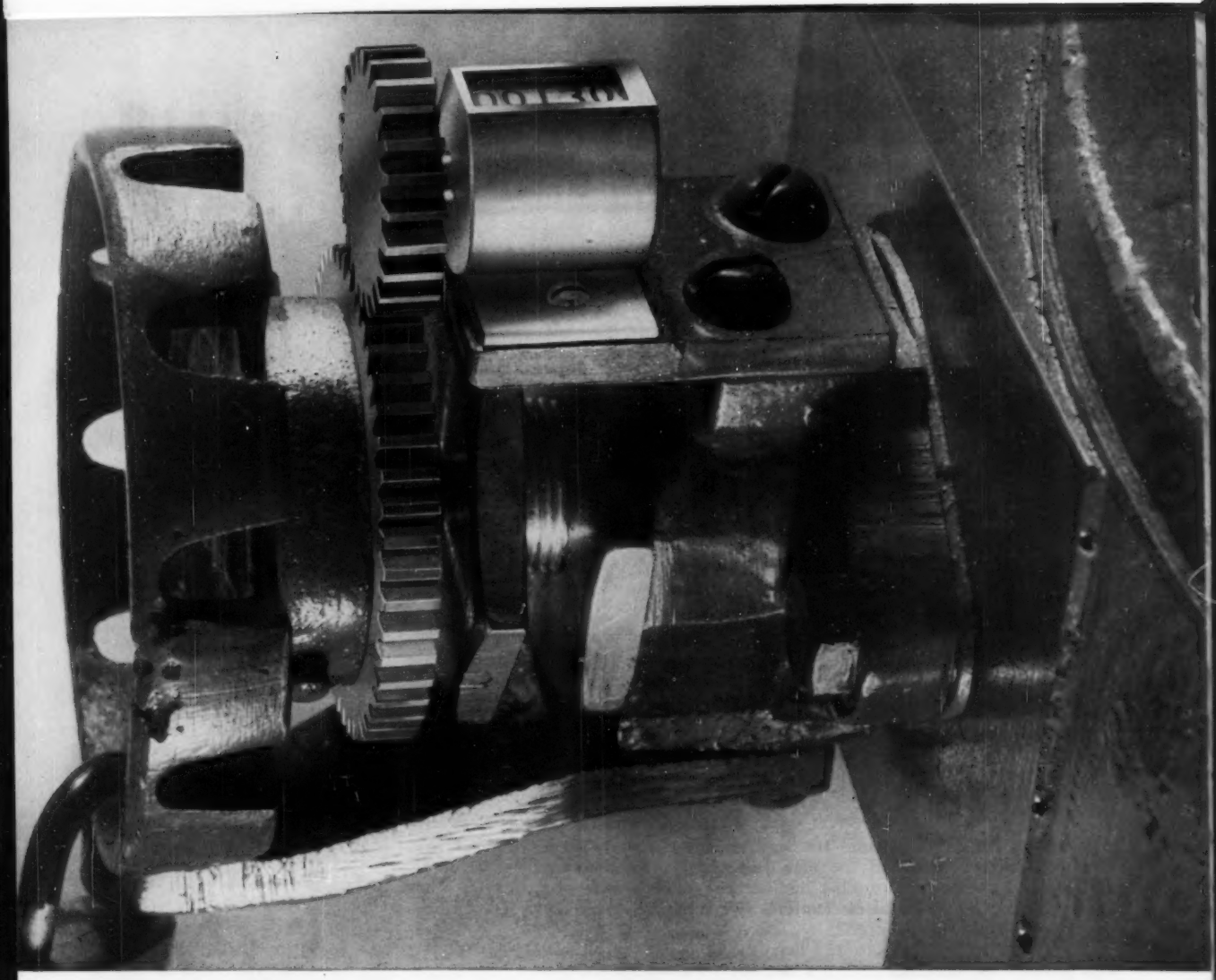
SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

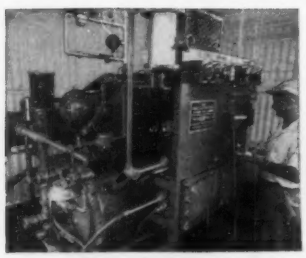
Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.



Air-Gas Ratio Valve

For precise control of inert gas quality . . .

Come to Kemp



This Kemp Model 3-MIHE Inert Gas Generator provides up to 3,000 cu. ft. per hr. at Quaker State's Farmer's Valley, Pa. plant. Like all Kemp units, it maintains a steady supply at even pressure, regardless of line demands!

Only Kemp Inert Gas Generators have the famous Kemp Industrial Carburetor at the vital heart of the process. This carburetor, developed and patented by Kemp, gives exacting control to the generation of inert gasses. From mere pilot burner operation to full generator capacity, inert gas analysis is exact and constant, regardless of demands on the system.

Kemp-produced inerts are low-cost inerts. You can use them liberally, at a fraction of the cost of bottled gasses, for purging, blanketing, controlling reactions, agitation, or any of a hundred applications. You get better quality control and increased safety at the lowest possible operational cost.

For round-the-clock inert production with minimum maintenance, depend on Kemp Inert Gas Generators. Your Kemp Representative will suggest the proper model to fill your needs. Or write us direct for Bulletin I-10. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

Kemp Convection Dryers

Kemp Immersion Melting Pots

KEMP OF BALTIMORE

Kemp Industrial Carburetors

Kemp Oriad Dryers

Men in the Industry . . .

University of Arkansas; Leggett has B.A. and B.S. degrees from Rice Institute; Lovering, a B.S. degree from the University of Oklahoma; Sims a B.S. degree from the University of New Mexico; Walstead, a B.S. degree from Rensselaer Polytechnic Institute; Henry a B.S. degree from Oklahoma State University; and Love, a B.S. degree from Georgia Institute of Technology.

D. C. Dunaway has been elected president of American Independent Oil Co. He has served over 20 years in various assignments with foreign affiliates of Standard Oil Co. (N. J.), his last post being that of president of Standard Oil Co. of Argentina.

Guy B. Hunter, chairman of the board of Quaker State Oil Refining Corp., has been re-elected president of National Petroleum Association. This will be his third term as president.

Rexford S. Blazer, of Ashland Oil & Refining Corp., was elected first vice president, and **John E. Selden,** of Pennzoil division, South Penn Oil Co., was elected second vice president.

Hunter was re-elected treasurer, a post he has held for many years, and **O. P. Keeney,** of Oil City, Pa., was re-elected recording secretary.

R. N. French has been promoted to senior mechanical engineer in the Technical division at Humble Oil & Refining Co.'s Baytown refinery. He handles design, maintenance and inspection engineering problems associated with the construction and maintenance of units processing light hydrocarbons at the refinery. He has a B.S. degree in mechanical engineering from Louisiana State University.

Henry Berk has been appointed a patent associate in the Patent division of Esso Research and Engineering Co. Berk, who earned his L.L.B. degree at Georgetown University, has been with Esso Research 20 years.

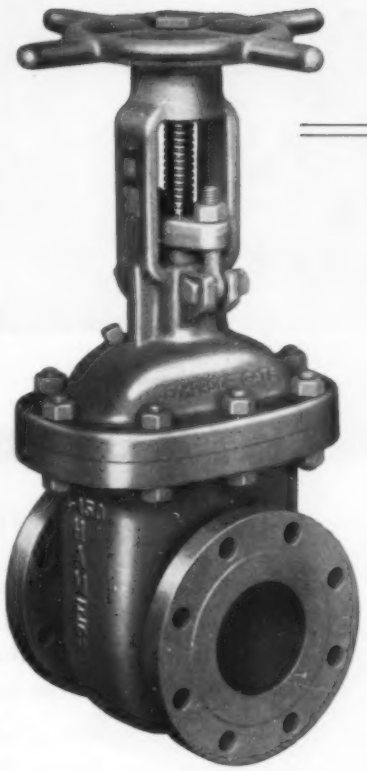
Kerryn King of The Texas Co. has been elected chairman of the committee on public affairs of the American Petroleum Institute. Vice president in charge of industrial and public relations for his company, he succeeds **Thomas W. Phelps** of Socony Mobil Oil Co., who resigned after he was named manager of his firm's Economics department.

Dr. William H. Schuette, of the Dow Chemical Co., and general manager of its Midland division, was elected a company vice president by the board of directors Sept. 10. He will continue his duties as division general manager. Dr. Schuette started his Dow career in the chemical engineering laboratory at Midland in 1941. He studied chemical engineering at Case Institute of Technology, receiving his B.S. degree in 1933, M.S. degree in 1939 and Ph.D. degree in 1941.

Paul Bilger has been named superintendent of Lake Superior Refining Co. **Joseph I. Lanctot** has been advanced from process foreman to assistant superintendent in charge of operations, and **Leo M. Zalaznik** has been promoted to assistant superintendent in charge of maintenance.

Bilger came to the refinery in 1955

New Hamer "Wedge Seal" LEAKPROOF GATE VALVE



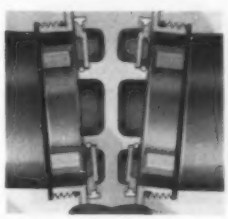
"DUAL" LEAKPROOF SEALING ACTION

POSITIVE SHUTOFF UPSTREAM — DOWNSTREAM

SERVICEABLE IN THE LINE

The new Hamer *Wedge-Seal*, unlike conventional Gates, incorporates a two-way sealing action that insures absolute line shut-off even on lines handling customarily hard-to-hold fluids. As the wedge is lowered to its precision metal-to-metal fit, a Teflon* seal in each side of the wedge compresses against the seats, forming a dual bubble-tight sealing action. Yet, with all of its added sealing quality, the new *Wedge-Seal* costs little more than a regular gate. Send for literature today. See for yourself how a Hamer *Wedge-Seal* can actually pay for itself.

*RTM DuPont



Renowned for their inert characteristics, Teflon seal rings used in the new Wedge-Seal have amazing durability, can be replaced, when necessary with minimum effort.

Hamer VALVES INC.

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Representatives throughout the world

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Please send immediately your Wedge-Seal Gate Valve Bulletin WS-1.

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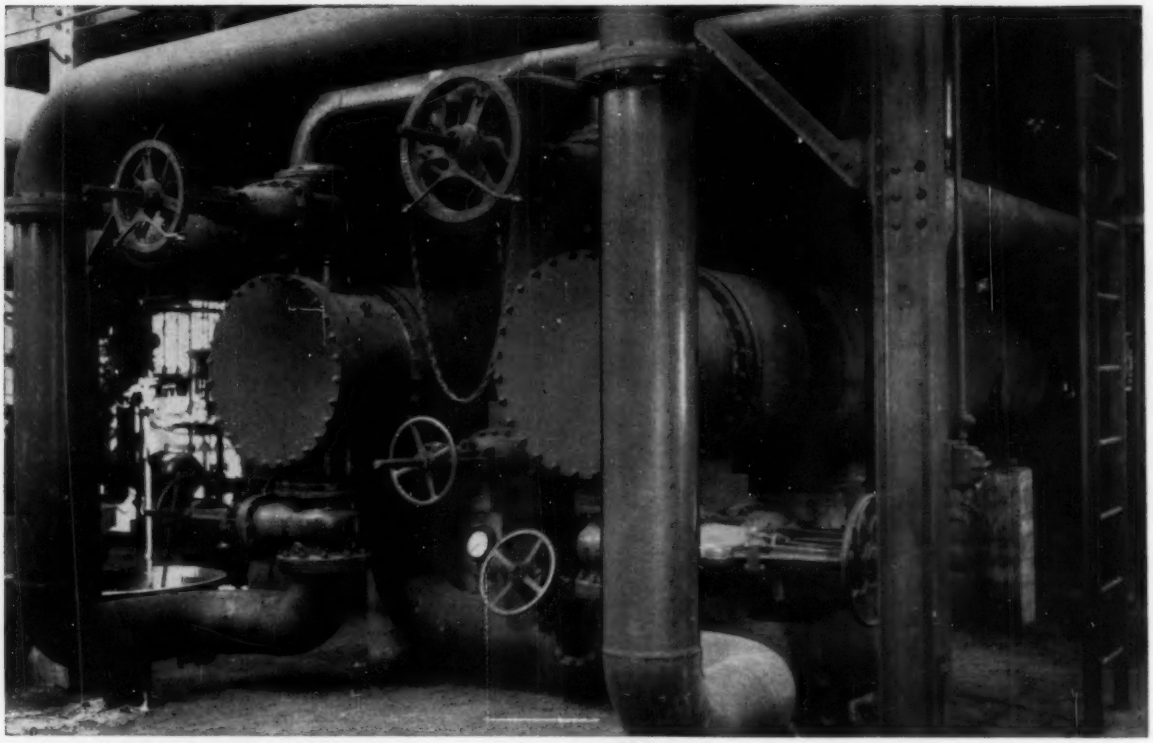
58-3

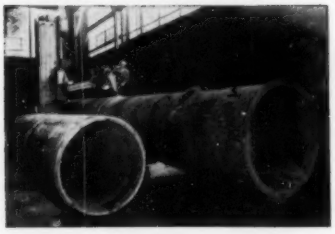
For more data on advertised products, use Readers' Service Cards, last page.



Two 31" x 19' 4" heat exchangers, with 1800 sq. ft. of heating surface each, installed in the plant of a large Eastern coke and coal chemicals company. In them, flushing liquor from the coke ovens heats a carbonate solution used in a special process for eliminating hydrogen sulphide from manufactured gas.

YUBA HEAT EXCHANGERS...

Engineered to Requirements



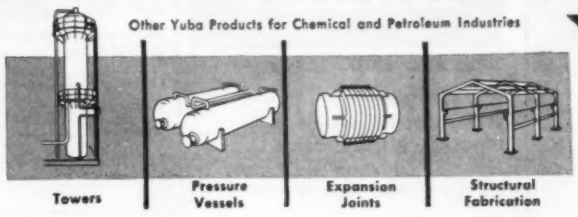
Yuba engineers scientifically rate and design heat exchangers to provide maximum heat transfer consistent with good operating practice. And to help rate these exchangers, Yuba has an electronic computer to make the *best* selection from many possibilities.

Yuba's superior engineering insures that initial cost of equipment is kept to a minimum. Proper design means low maintenance, with the end result a profitable operation. You will find Yuba's plants in the East and West thoroughly experienced in working with alloys as well as with time-tested carbon steel.

Heat Exchangers manufactured by
YUBA HEAT TRANSFER DIVISION, Honesdale, Pa.; ADSCO DIVISION, Buffalo, N. Y., and YUBA MANUFACTURING DIVISION, Benicia, Calif.

YUBA CONSOLIDATED INDUSTRIES, INC.

Other Yuba Products for Chemical and Petroleum Industries



and has served as chief engineer until the present time. Lanctot has been with the refinery since it began operations in 1951. He started as a process helper and was promoted to chief operator and process foreman before being named to his new post. Zalanik also started as a process helper when the refinery began operations in 1951. Before attaining his new position, he was a maintenance foreman.

G. C. Richardson has been elected a director of Cities Service Oil Co. He is manager of the company's Supply and Distribution division. He joined Cities Service in 1936 and served in the company's Marketing division from 1946 to 1955 as regional manager, and manager of operations. Richardson transferred to Bartlesville in 1955 to manage the Supply and Distribution division.

Dr. Clark A. Dunn, director of engineering research at Oklahoma State University, has been elected president of the National Society of Professional Engineers.

H. A. Lord, superintendent of The Texas Co.'s Lockport, Ill., works, has been appointed general manager of the company's Engineering department.

R. E. Nagle, assistant chief engineer, has been named to succeed chief engineer **H. B. Peters,** who has retired. Lord and Nagle will have New York headquarters.

Rawleigh Warner, Jr., manager of Socony Mobil Oil Co., Inc.'s Economics department has been appointed manager of the Department of Middle East affairs. He has been in the oil industry since 1948. He joined Mobil in 1953 as assistant to the vice president and director of finance of Socony-Vacuum Overseas Supply Co., Inc.

Dr. John W. Kraus has been appointed a research chemist by The M. W. Kellogg Co. Formerly with Argonne National Laboratories, he will work with mass spectrometry.

Dr. Kraus holds B.S., M.S., and Ph.D. degrees in chemistry from Ohio State University.

Dr. Samuel M. Darling has been promoted to research supervisor in the Chemical and Physical Research division of The Standard Oil Co. (Ohio) in Cleveland.

–Deaths–

C. O. Willson, a member of the Oil and Gas Journal editorial staff for 36 years and its editor for 17, died September 19 following a heart attack. He joined the Journal in 1922 and became editor in 1936.

Harley Roscoe Johnson, 65, of Tulsa, owner and president of Akin Gasoline Co., died September 20.

W. R. Pinnell, 67, retired Sinclair Refining Co. district superintendent at Springfield, Mo., died Sept. 19 at his home in Tulsa after an extended illness. He had been with Sinclair 24 years and moved to Tulsa in 1956.

Lloyd G. Smith, 67, a retired vice president and director of Creole Petroleum Corp., died Sept. 9 at his home in Media, Pa., of a heart attack. He graduated from the University of Illinois in 1913 with a B.S. degree in mechanical engineering, started his career in the petroleum industry as a draftsman, and went on to become president of Lago Oil and Transport Co., Ltd., and later a vice president and director of Creole.

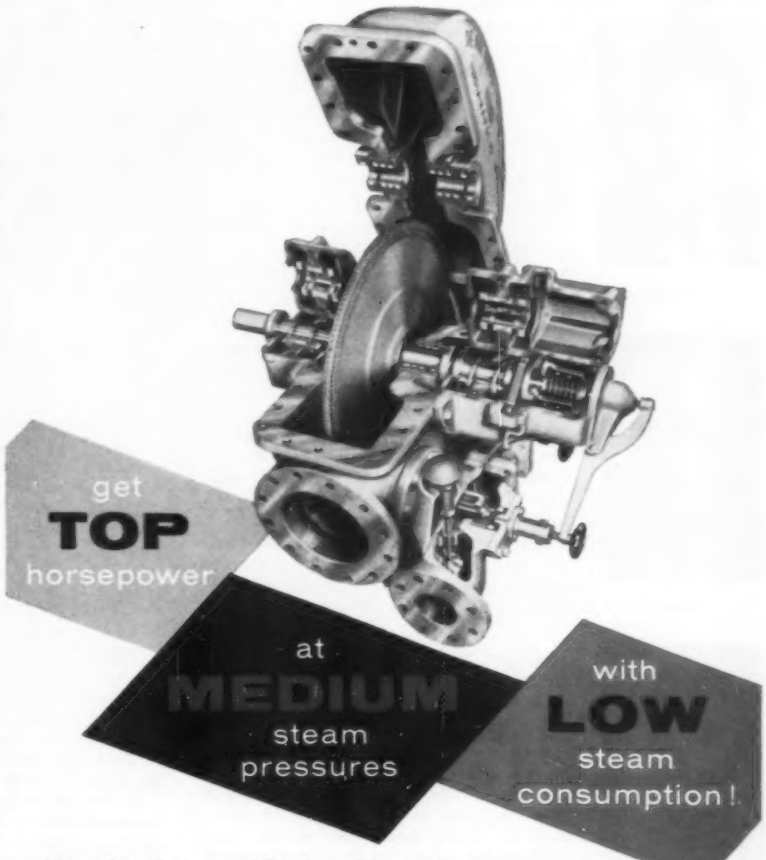
Joseph St. G. B. Nolan, 65, retired managing director of the Standard-Vacuum Oil Co. of South Africa, died in Cape Town, N. Y., Sept. 7. He is survived by his wife, a son and a daughter.

A. W. Peake, 68, who retired as president of Standard Oil Co. (Ind.) in 1955, died August 28 at Dundee, Scotland. He had been president 10 years and a director for 25 of the 34 years he served the company. He was associated for nearly four decades with Frank O. Prior, present chairman, and for a decade with Dr. Robert E. Wilson, who retired as chairman early in 1958.

Men in the Industry . . .

Millard H. Poole, 53, manager of Sun Oil Co.'s Ohio Valley sales region, died Sept. 11 in a Cincinnati hospital, after suffering a heart attack. He joined Sun in 1922 as a clerk in the Auditing department in Philadelphia. He had been manager of the Ohio Valley region since its creation in 1951.

Daniel Steen Fletcher, 65, died August 28 in Los Angeles following a long illness. Founder of Fletcher Oil Co., he has lived in Los Angeles since 1935.



Choose from the improved DH Line of Dean Hill horizontal turbines which give you up to twice the power of earlier models while maintaining the same economy of operation.

The major change contributing to this tremendous power increase is the addition of steam nozzles to all models. On types now built with two nozzles—DH-10, DH-15, DH-20, DH-25—this change has meant *a 100% increase in the maximum horsepower of each unit!* On new three-nozzle models—DH-30, DH-35, DH-40, DH-45—the rated increase in maximum horsepower is 50%!

Why not get the complete power picture of Dean Hill's improved DH Line of horizontal turbines? Write today for Turbine Catalog, No. 500.

DEAN DH HILL PUMP COMPANY
Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

OFFICES IN PRINCIPAL CITIES

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Whitson

Leo E. Whitson, head of the newly-formed Whitson Engineering Co., Dallas, announced that the firm has been appointed a Master Distributor for the U. S. Gauge division of American Machine and Metals, Inc. Whitson Engineering, as a USG distributor, will cover process plants, contractors, and general industrial plants in the Dallas area.

Company head Leo E. Whitson, graduated with a B.S. degree in mechanical engineering from the University of Texas and was engaged in selling in the Dallas area for a number of years.

Grimstad

Gordon T. Grimstad has been appointed sales manager of Bendix Filter division, Bendix Aviation Corp. He has been with Omark Industries, Portland, as administrative assistant to the president, sales manager of the Special Products division, and advertising manager for all products. He has also been an engineer for Allis-Chalmers Manufacturing Co.

Grimstad is a mechanical engineering graduate of the University of Wisconsin and has a M.B.A. degree from Harvard Business School.

Sanders

C. Horace Sanders has been appointed Southwest district manager of The Cooper-Bessemer Corp. He has been with Cooper-Bessemer since 1927, and served in the company's Shreveport office before joining the Dallas office in 1931. He was promoted to assistant Southwest district manager in 1946 and has served that position continuously until his recent promotion.

Sanders is active in the Petroleum Engineers Club of Dallas, the Texas Society of Professional Enginers, Registered Professional Engineers in Texas and AIME.

Bean

Howard S. Bean has been retained as consultant on flow measurement by The Foxboro Co. The appointment became effective July 1.

Bean was formerly with the National Bureau of Standards where he served for 28 years as chief of the Gas Measuring Instrument section. For the past 10 years, until his recent retirement, he has been chief of the Capacity, Density and Fluid Meters section. His association memberships include several committees of the ASME and AGA.

Klafstad

Erling Klafstad has been elected president of Crosby Valve & Gage Co. and its affiliate, The Ashton Valve Co. He was formerly associated with Manning, Maxwell & Moore, Inc., of Stratford, Conn., as assistant director of engineering, Consolidated Ashcraft, Hancock division. Prior to this, he had been with Crosby, serving successively as development engineer, chief engineer, and executive vice president. Klafstad is a member of ASME, ASM, ISA, ASNE, and API.

Sepura

Walt S. Sepura has been elected vice-president and plant manager of John Wood Co.'s Bennett Pump division. He had been scheduled to become vice president and plant manager of the Heater and Tank division plant in Chicago by a recently-announced election. However, the company's revised decision is that his capabilities can best be utilized by keeping him at Bennett with increased executive responsibilities in that division.

With the company since 1925, Sepura has been factory manager of Bennett Pump plants at Muskegon and Hart, Michigan, since 1952.

Steinbruch

Robert Steinbruch has been appointed manager of contract research for Minerals & Chemicals Corp. of America. In his new position, he will utilize M&C's research facilities for sponsored research and development work.

Steinbruch joined Minerals & Chemicals in 1954 in the Application Research department. He has been technical assistant to the director of research and most recently served in the Sales Technical Service department in adsorbents and catalyst sales.

Stairs

William F. Stairs has been named production manager of Halikainen Instruments, Berkeley, Calif. He has a B.S. degree in electronic engineering from California State Polytechnic College and studied business administration at Kings College. From 1942 to 1946 he was an electronics teacher with the Air Force. Previous experience in production control in instrumentation was with Berkeley division of Beckman Instruments from 1951 to 1955, when he resigned to accept a position as production control manager at the Western division of Tracerlab, Inc.

Combs

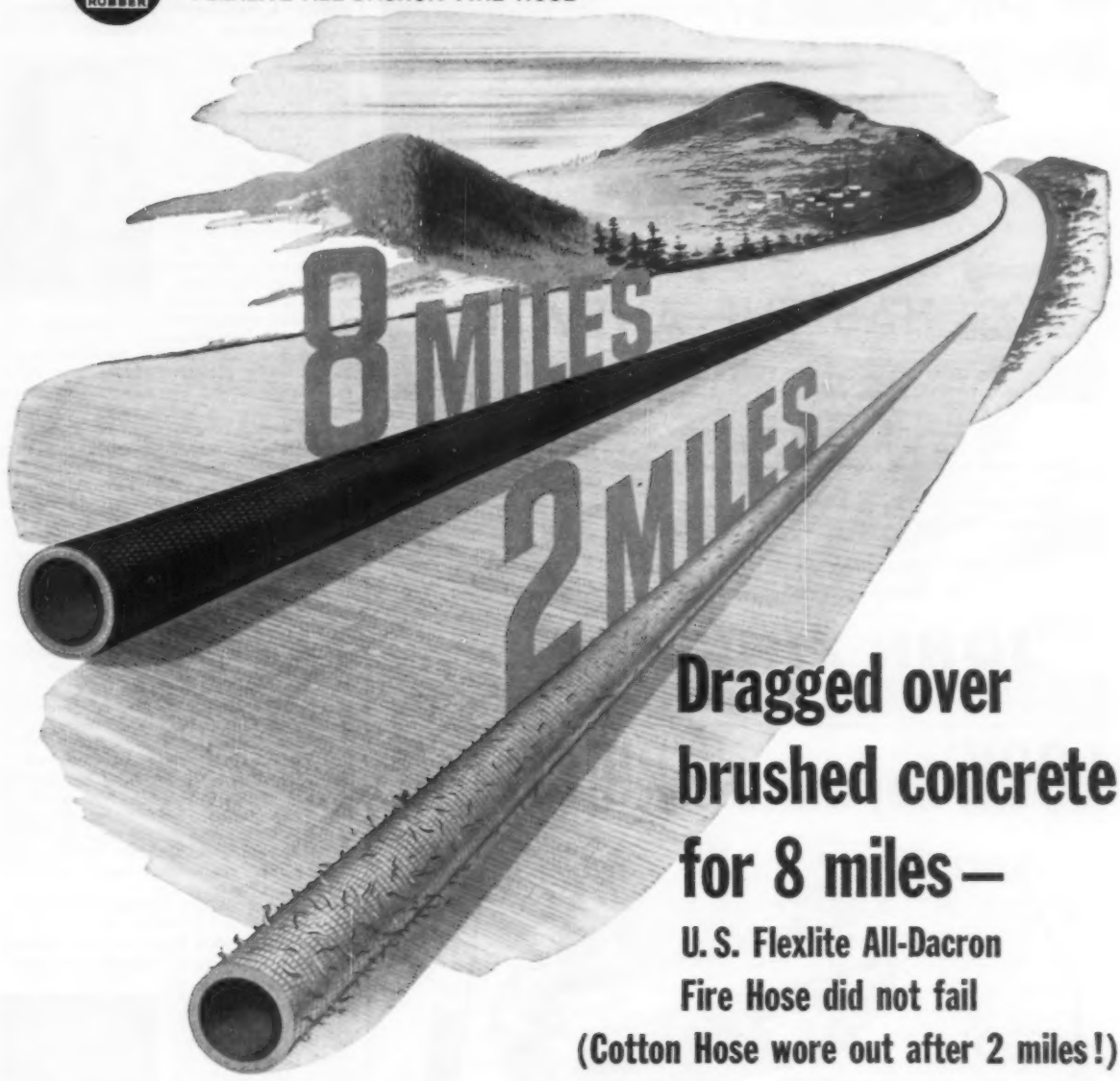
Wilbur E. Combs has been appointed manager of development for the Mechanical Goods division, U. S. Rubber Co. He has held a wide variety of executive positions with the company, having joined it in 1945 as a special representative for the Mechanical Goods division at Kansas City.

In his new assignment he will retain his responsibilities in market research and will continue to have headquarters at Passaic, N. J. Combs has a B.S. degree in engineering from the University of Tulsa and has recently studied marketing at Columbia University school of business.

Storey

E. E. Storey has joined Jones & Laughlin Supply division at Tulsa as supervisor of tank sales. He attended the University of Kansas, and entered the industry as a salesman for gasoline pumps and lube equipment in 1936. From 1939 until 1940 he was sales engineer in Western Kansas for Unit Rig Co. He joined Erie Pump Co. in 1940 and remained with them in sales until 1942, when he joined Black, Sivalls & Bryson Tank Co. as a salesman. In 1945, Storey joined Maloney-Crawford Tank & Manufacturing Co. He joined Continental Tank Co. in 1951, where he remained until transferring to J&L.

FLEXLITE ALL-DACRON FIRE HOSE



Dragged over brushed concrete for 8 miles—

U. S. Flexlite All-Dacron Fire Hose did not fail

(Cotton Hose wore out after 2 miles!)

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Suppliers . . .

JONES & LAUGHLIN SUPPLY DIVISION's C. J. Jernigan, traffic manager for the company, has retired. He has been active in the transportation field for 48 years, having begun his career with the Missouri, Oklahoma & Gulf Railway Co. at Muskogee, Okla., in 1910. He later joined the Western Weighing & Inspection Bureau, the Frisco Lines, Universal Carloading Corp., and was in the Motor Transport business for 12 years. Jernigan joined Jones & Laughlin in 1942 as assistant traffic manager, and became traffic manager in 1948.

Jernigan

NORTON BEHR-MANNING OVERSEAS, INC. has reported that **Herbert A. Stanton**, 71, former president and director of the company and vice president and director of Norton Co., died August 26 at his home in Harwichport, Mass.

He began his career with Norton Company in 1912 as credit manager, and retired in 1952.

WALKER & ASSOCIATES, INC., consulting engineers, has expanded its activities by forming Walker Constructors, Inc. to carry-out construction and maintenance services. The newly formed corporation will specialize in refinery, petrochemical, and pipeline construction and maintenance.

Vice president and general manager is J. Leon Bates, former chief engineer at the Texas Butadiene & Chemical Corp. plant in Channelview, Texas. A graduate of Mississippi State College, he was once maintenance engineering supervisor with Magnolia Petroleum Co.

JOHN WOOD CO.'s Bennett Pump division has elected **Walter C. Chaffee** vice president and director of engineering. He has been Bennett's director of engineering since 1956, when he joined the division staff. He has had more than 25 years of product engineering and administrative experience with Keller Tool Co., his own engineering consulting firm, Curtis Wright Corporation and Douglas Aircraft Co.

Chaffee

Chaffee received his engineering degree from the University of Michigan and took post-graduate work in business organization and management at the University of Southern California.

ALCO PRODUCTS, INC. has named **John H. Chandler** materials control supervisor for the Petroleum Industry Equipment division, with headquarters in Beaumont. He has been with ALCO for 16 years.

Chandler began his career in Schenec-

tady and was renewal parts manager in the Transportation division in St. Louis for 12 years before being assigned to Beaumont. He will have responsibility for all requisitioning, stocking and disbursing for the Beaumont plant.

DAVISON CHEMICAL CO. has placed its chemical service activities under **F. Emerson Ivey, Jr.**, as manager. Formerly in charge of petroleum catalyst technical service, he came to Davison in 1918 from Gulf Oil Corp. He is a chemical engineering graduate of Lehigh University.

Michael M. Dexter will work with **J. N. Pryor** in Davison's Technical Service laboratory, at Curtis Bay, Baltimore.

DRESSER INDUSTRIES, INC.'s Connersville Blower division has named **W. W. Harris** vice president, marketing, for the U. S. and Canada. A graduate of the University of Oklahoma, Harris has eleven years' marketing management experience.

AMERICAN CYANAMID CO.'s Industrial Chemicals division has appointed **Joseph D. Lowery** assistant general sales manager. He was formerly manager of the company's Heavy Chemicals department, and has held a variety of executives sales and administrative posts with the company.

MONSANTO CHEMICAL CO.'s Inorganic Chemicals division has named **David C. Hale** supervising engineer in the Construction section. He was formerly maintenance supervisor at the company's Trenton plant.

HAYNES STELLITE CO. has appointed **John D. Leslie** assistant district sales manager of the New York district office. He joined the company in the sales department and two years later moved to the New York district as a field engineer.

SELAS CORP. OF AMERICA has appointed **Cecil L. Kerr** sales representative in the company's Pittsburgh Sales district. He joined the company from Salem Brosius, Inc., where he was chief engineer, furnaces.

JEFFERSON CHEMICAL CO., INC., has named **J. W. Gilroy** export sales manager. He will be responsible for administration, planning and direct sales activities in foreign markets.

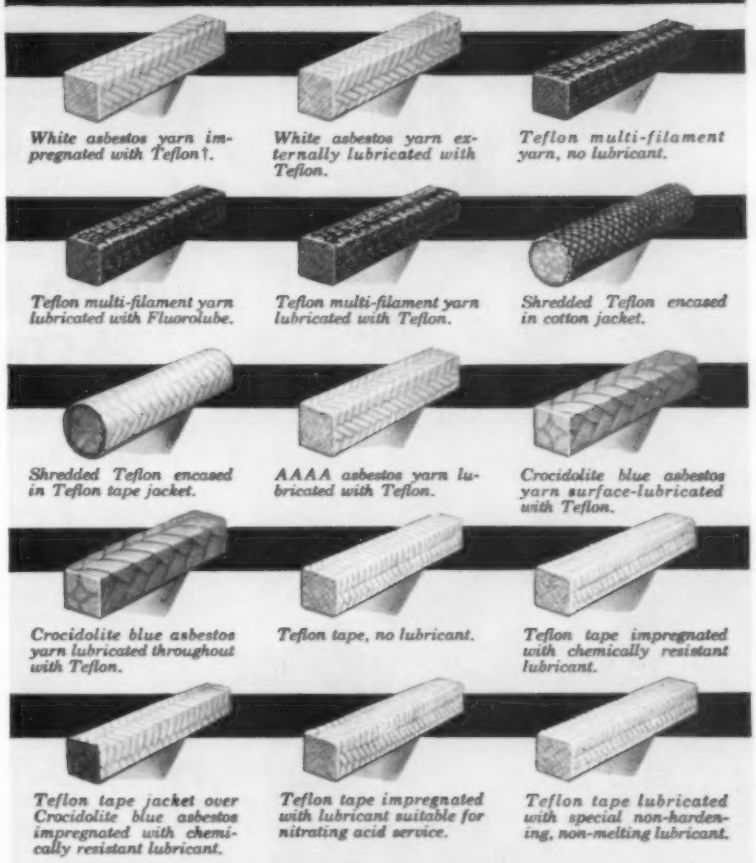
Gilroy has a B.B.A. degree in accounting from Manhattan College. Following graduation, he joined Jefferson's Marketing department in New York.

JOHN WOOD CO.'s Bennett Pump division has named **Arch F. Jordan** senior vice president and general manager. He has 35 years' experience in the petroleum industry equipment business. In 1946 he joined Bennett Pump as vice president and director of sales. He became general manager of the division in 1951. Prior to his association with Bennett, Jordan was vice president and general manager of the United States Air Compressor Co.

SOUTHERN PIPE & CASING CO. has named **C. E. Lamar** assistant sales manager. A graduate of the California Institute of Technology, he has been in engineering and sales at Southern Pipe for seven years.

HOUDAILLE INDUSTRIES, INC. has announced two divisional executive promotions. **E. L. Spencer**, who has been chief executive at Fairmount Tool & Forging, Inc., since its acquisition by Houdaille in

15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES


White asbestos yarn impregnated with Teflon†.
White asbestos yarn externally lubricated with Teflon.
Teflon multi-filament yarn, no lubricant.
Teflon multi-filament yarn lubricated with Fluorolube.
Teflon multi-filament yarn lubricated with Teflon.
Shredded Teflon encased in cotton jacket.
Shredded Teflon encased in Teflon tape jacket.
AAAA asbestos yarn lubricated with Teflon.
Crocidolite blue asbestos yarn surface-lubricated with Teflon.
Crocidolite blue asbestos yarn lubricated throughout with Teflon.
Teflon tape, no lubricant.
Teflon tape impregnated with chemically resistant lubricant.
Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant.
Teflon tape impregnated with lubricant suitable for nitrating acid service.
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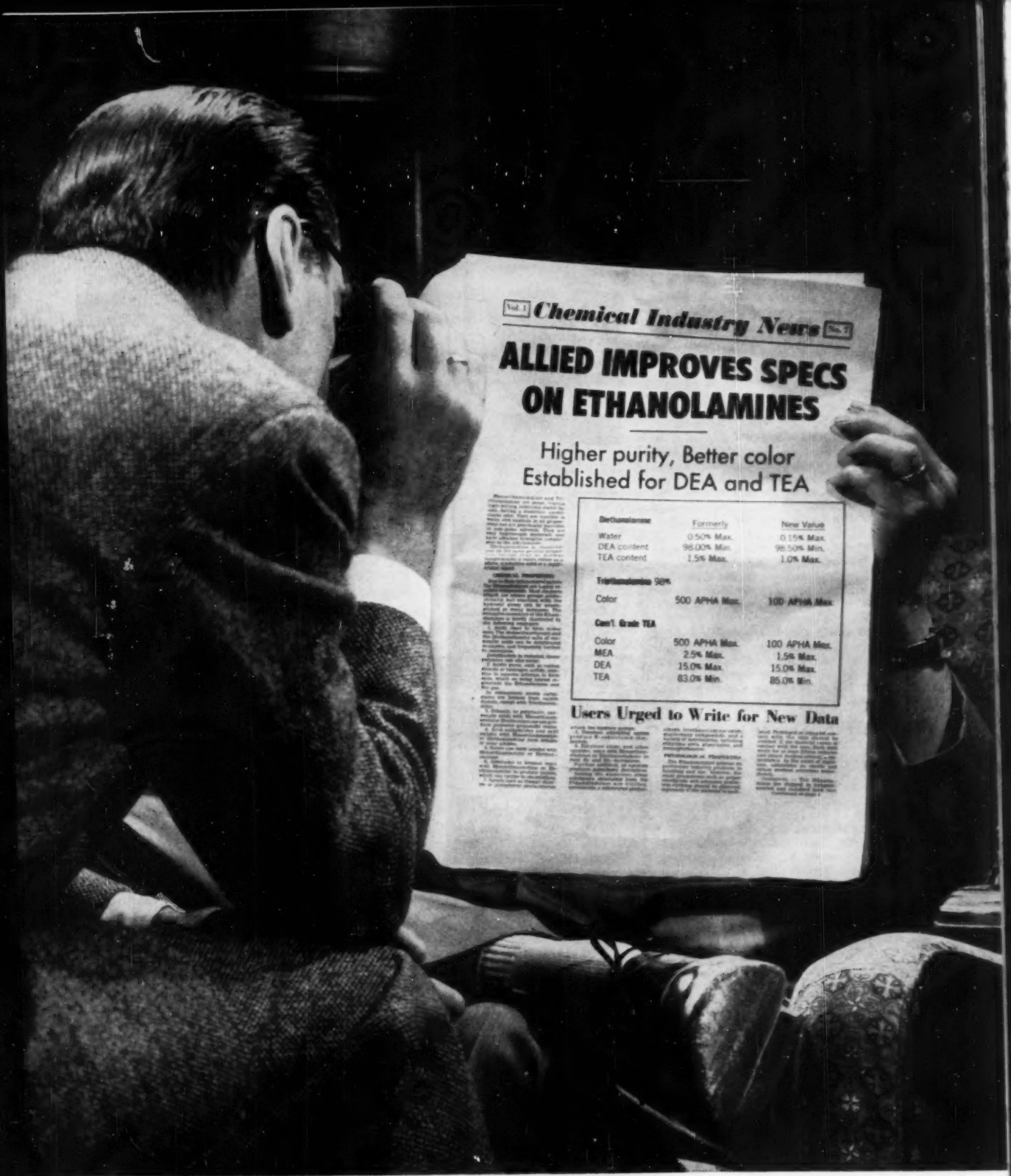

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Suppliers . . .

1955, has been appointed general sales manager of the Buffalo Hydraulics division. He has been in industrial sales and manufacturing for nearly 30 years.

A. J. Fratianne has been with Fairmount for 23 years. For the past seven years, he has been factory manager and now moves to the position of general manager.

MONSANTO CHEMICAL CO. has appointed **L. L. Baseler** director of administration of the Overseas division. He has been associate director of marketing for the Overseas division since April, 1948. He joined Monsanto in 1933.

JONES & LAUGHLIN SUPPLY DIVISION has named **R. N. Maples** manager of the Traffic department. He had been with Southwestern Freight Bureau in St. Louis, Mo. from 1934-1958.

MONSANTO CHEMICAL CO. has elected **Patrick J. Dowd** company treasurer. He has been director of administration for the Overseas division.

THE CHAS. TAYLOR SONS CO. has appointed **Henry J. Calnen** eastern representative. A graduate of Yale University he will cover the New England states, New York and northern New Jersey.

SOUTHWESTERN ENGINEERING CO. has named **J. B. Allinson** regional sales representative in the mid-continent and southwest areas of the nation. He will represent the Engineering and Construction division.

A University of Texas graduate in chemical engineering, Allinson has been previously associated with Merritt-Chapman & Scott, Wyatt C. Hedrick, Braniff Airways, and Ford, Bacon & Davis on the Oak Ridge Atom Bomb project.

DOW CHEMICAL INTER-AMERICAN has appointed **Thomas G. Johnson** manager of the Buenos Aires, Argentina, sales office. He will assist Dow Inter-American's representatives in Argentina, Bolivia, Chile, Ecuador, Paraguay, Peru and Uruguay in the sale of Dow products.

Johnson was formerly assistant manager of the Montevideo office in Uruguay. He graduated from the University of Notre Dame and joined The Dow Chemical Co. in 1951.

BORG-WARNER CORP.'s Marbon Chemical division has appointed **D. M. Pratt** and **William A. Suiter** sales managers for some of the company's products.

With Marbon since 1934, Pratt will supervise an enlarged sales program, while Suiter will supervise the marketing of Marbon's newest thermoplastic material. Suiter came to Marbon recently from the Panelyte division of St. Regis Paper Co.

CONSOLIDATED ELECTRODYNAMICS CORP.'s Central Engineering division has appointed **Francis T. Greenup,** formerly chief product engineer, manager of engineering services and the Alectra department.

George M. Slocomb, formerly supervisory principal engineer, was promoted to assistant chief development engineer, and **E. James Penrose** was named administrative manager. Greenup joined CEC in 1955 as chief design engineer and became chief product engineer in 1957. Slocomb, a graduate of the University

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Suppliers . . .

of Southern California with a B.S. degree in electrical engineering, has been with CEC in various engineering capacities since 1950. Penrose, a graduate of McGill University in Montreal, joined Consolidated in 1957.

GRAVER WATER CONDITIONING CO. has appointed Crane Engineering Sales, Inc. exclusive engineering representatives for most of Wisconsin and the Northern Michigan peninsula. They will handle Graver equipment for industrial water and waste treatment, and chemical processing.

THE OAKITE CO. has named **James B. Caldwell, Jr.**, manager of the San Francisco office. Formerly manager of the organization's Portland office, Caldwell is a graduate of Stanford University with a degree in electrical engineering.

AMERICAN CYANAMID CO.'s Industrial Chemicals division has named **Joseph D. Lowery** assistant general sales manager. A veteran of 36 years with Cyanamid, he was formerly manager of the company's Heavy Chemicals department. He has also held a variety of executive sales and administrative posts with the company.

ALCO PRODUCTS, INC. has appointed **Art Makris** a sales engineer specializing in heat exchanger sales. He joined ALCO last October and was assigned to the company's Petroleum Industry Equipment division with headquarters in Houston.

Prior to joining ALCO, he was a process design engineer with Eastern States Petroleum Co., Houston. Makris is a chemical engineering graduate of Newark College of Engineering.

M. R. Lovering has been named sales engineer in heat exchanger repair and rebuilding, working out of the Beaumont plant.

GRAVER TANK & MANUFACTURING CO.'s International division has established an office in Caracas, Venezuela, with **William I. Woodson** as general manager.

A long-time resident of Venezuela, he formerly was manager of the Venezuelan division of Texas Petroleum Co., and in Turkey was petroleum advisor to the Turkish government. **Erwin C. Barnes**, a Graver field engineer was named Woodson's assistant.

SELAS CORP. OF AMERICA has transferred **Robert M. Breckenridge** from sales representative, St. Louis Sales district, to sales representative, Houston district. The Houston Sales district has been increased to include Louisiana, Oklahoma and Texas.

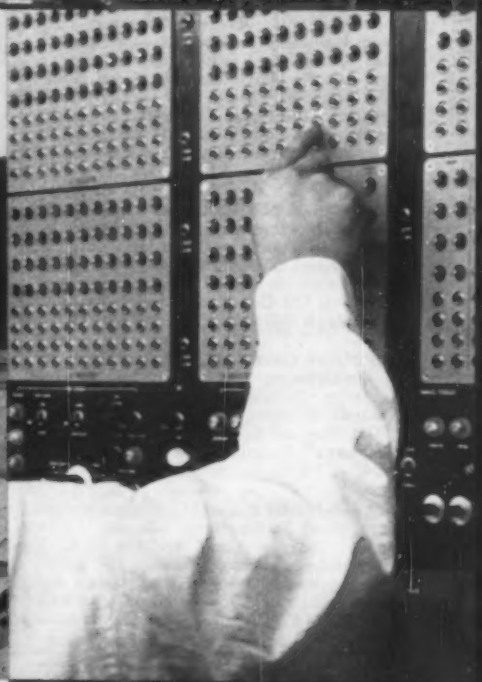
Breckenridge joined Selas in 1947 as a design engineer, later became an application engineer, and in 1954 was assigned to the St. Louis sales district. He was formerly an engineer with Stokes and Smith Co., and Budd Co., both of Philadelphia.

FLEXONICS CORP. has appointed **Edward A. Malling** vice president of marketing. He was formerly manager of marketing for the Specialty Electronics Components department of General Electric Corp.

THE DOW CHEMICAL CO. has appointed **G. J. Williams** to succeed **Donald L. Gibb** as sales manager, Plastics department. He has been Gibb's assistant since 1956.

Gibb will continue with the Sales department, assuming new duties as a spe-

Fluor's Datatron digital computer frees engineers from routine computation, permitting full use of their creative design talents. Its ability to quickly perform intricate calculations without error shortens engineering lead time . . . assures maximum precision and efficiency in completed plants.



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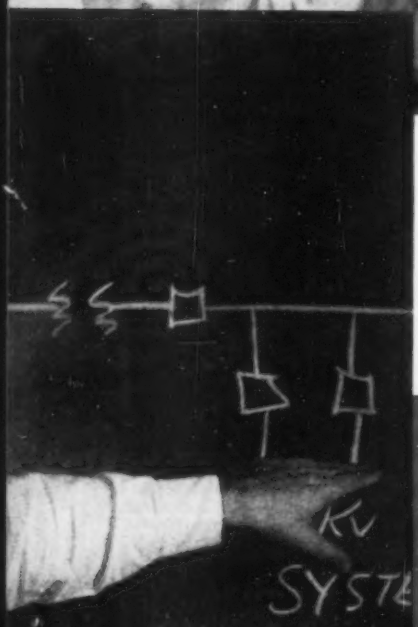

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Suppliers . . .

cial consultant, concerned especially with the plastics field.

Williams joined Dow in 1948 as an attorney with the Legal department. He was with the Textile Fibers department before his appointment as Gibb's assistant.

Gibb came to Dow in 1923 and has been active in plastics sales work for more than 20 years.

AMERICAN CYANAMID CO. has formed a Process Chemicals department in its Industrial Chemicals division. The new department was created through merger of the company's Heavy Chemicals and Manufacturers Chemicals departments.

H. C. Milton has been appointed manager and **R. M. Goddard** has been named sales manager. Milton was formerly manager of the Manufacturers Chemicals department, and Goddard was assistant manager of the Heavy Chemicals department.

THE OHIO INJECTOR CO. has named **Owen H. Walker** Houston and Gulf Coast district sales manager. After receiving an engineering degree from the University of Houston in 1951, he was associated with Gulf Oil Co. in sales and supervisory assignments.

PETROLEUM CHEMICALS, INC. has organized a Development department comprising Research, Projects Analysis and Market Analysis divisions.

Dr. Howard L. Malakoff, head of the company's Technical department since 1954, will head the new department.

CLEAVER-BROOKS CO. has broken ground for a plant at Stratford, Canada. To be readied for occupancy by late 1958, it will produce packaged boilers for industrial process and heating applications, and institutional and commercial installations.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, and JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF PETROLEUM REFINER, published monthly at Houston, Texas, for October, 1958.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Wm. G. Dudley, 4742 Banning, Houston, Texas; Editorial Director, Silas B. Ragsdale, 1636 North Boulevard, Houston, Texas; Editor, George Gibbs, 9214 Timberside Drive, Houston, Texas; Managing Editor, Wallace Fitzgerald, 5423 Lymbar, Houston, Texas; Business Manager, Robert M. de Sombre, 4410 Ingersoll, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; June Wooden Bliss, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; Mrs. Grace C. Carter, Dallas, Texas; Mrs. Margaret D. Cashman, Beaumont, Texas; Drum & Company, c/o Trust Department, Houston, Texas; P. Stinson Dudley, Eldorado, Texas; Ray L. Dudley (Deceased), Houston, Texas; Wm. G. Dudley, Houston, Texas; William V. Gross, Alpine, Texas; Mrs. Carolyn Dodson Keeble, Abilene, Texas; Mrs. Anita S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Mrs. Sallie Windham Ridley, Houston, Texas; Walter Gage Sterling—Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: NONE.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

R. M. de SOMBRE
Business Manager

Sworn to and subscribed before me this 19th day of September, 1958.

P. J. AUCOIN
(Seal) Notary Public in and for Harris County, Texas.
(My commission expires June 1, 1959.)

The incoming board of directors of the Natural Gasoline Supply Men's Association, elected for the 1958-59 term, took office at its first scheduled meeting in Dallas.

Members of the board are, (l. to r.) seated: C. P. Stanley, Dresser Engineering Co., Tulsa; Rudy Zorn, Cameron Iron Works, Houston; W. F. Hildebrand, General Electric Co., Tulsa; W. F. Matheny, Arrow Industrial Mfg. Co., Tulsa; incoming President H. O. Sears, Alliger & Sears Co., Houston; G. C. Thrift, Koch Engineering Co., Wichita; retiring President Jimmy Dvoracek, Nordstrom Valve Div., Rockwell Mfg. Co., Houston; E. L. Stark, The Foxboro Company, Dallas; A. F. Canada, Pacific Pumps, Inc., Huntington Park, Calif.; R. P. Walker, Minneapolis-Honeywell Regulator Co., Oklahoma City; Jimmy Okeson, Refinery Supply Co., Tulsa.

Standing: C. Victor Bolles, Davison Chemical Co., Houston; F. W. Bell, Brown & Root, Inc., Houston; J. B. Zachry, Worthington Corp., Houston; James S. Kone, James S. Kone Co., Amarillo; Ray F. Riddle, Riddle & Hubbell Co., Tulsa; T. R. Cross, Paramount Supply Co., Aramillo; E. O. Haltom, Trinity Steel Co., Inc., Dallas; James E. Hughes, Western Supply Co., Tulsa; I. Earl Nutter, Nutter Engineering Co., Tulsa.

A closer study of product lines characterized the general sales meeting of sales personnel of W. C. Norris, Manufacturer, division of Dover Corp., Tulsa, just completed under the direction of G. W. Davidson, Jr., vice president sales. Representatives of Oklahoma, Louisiana and East Texas, Kansas, Rocky Mountain and Illinois Basin areas met in the Tulsa home office for concentrated attention on sales programming and product lines. Attending were: First row, J. E. Giles, city sales; A. L. Ethriedge, Oklahoma City; D. P. Hagaman, sales manager; William L. Butler, president; G. W. Davidson, vice president, sales; J. A. Getty, division sales manager; J. C. Schaff, Tulsa. Second row: Dan Coates, Farmington, N. M.; Homer Hill, Ardmore; Bill Forcum, Denver; Bill Peterson, Shreveport; W. C. Tolleson, Kilgore, Texas; Don Durbin, Lafayette, La.; Kenneth Hance, Salem, Ill.; A. A. Hardy, chief engineer. Third row: Clyde Sights, Tulsa; Earl Carpenter, Tulsa; J. G. Russell, Oklahoma City; LeRoy Mitchell, Casper, Wyo.; Earl Johnson, assistant chief engineer; R. L. Preston, Wichita; R. A. Colgin, vice president, manufacturing; Bill Robinson, Calgary, Alberta; C. T. Fair, Great Bend, Kan.

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For more data on advertised products, use Readers' Service Cards, last page.

Reviewing New Books . . .

Flow Meter Engineering

The eighth edition of "Principles and Practice of Flow Meter Engineering," by L. K. Spink, is now available. It contains the latest developments in flow measurement, making it a complete and authoritative text book. It is conveniently arranged and indexed so that it can be used as a handbook for every-day one-source reference in commercial flow measurement.

The informative text covers the entire field of flow measurement, including such subjects as the history of developments in flowmetering, the theory of flow meters, the use and installation of primary devices, meter mechanisms, and liquid, steam and gas flow measuring practices.

(Spink, L. K., *Principles and Practice of Flow Meter Engineering*, The Foxboro Co., Foxboro, Mass., 549 pages, $15.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Revised American Standards

Two revised booklets on American Standards are available from the American Standards Association. They are "Letter Symbols for Hydraulics" and "Letter Symbols for Heat and Thermodynamics." The first is part of a series of letter symbol standards developed by the ASA under sponsorship of the ASME.

An effort is made to achieve reasonable conformity among the letter symbols for related fields.

Many subfields of hydraulics have been reviewed in the composition of the new standard list of symbols, including hydraulic turbo-machinery, water waves, sediment transport, hydrology, industrial hydraulics, etc.

The second booklet is also sponsored and published by ASME for letter symbols in the industry. Where symbols are used in several fields and incorporated in the respective American Standards, this is indicated by cross references.

Particular emphasis has been given to the breadth of the field so that accepted practice in fundamentals established by the chemist and physicist, as well as in all fields of engineering, is represented.

(ASA *Letter Symbols for Hydraulics, American Standard Y10.2-1958* ($1.00), and *Letter Symbols for Heat and Thermodynamics, American Standard Y10.4-1957* ($1.50), American Standards Association, 70 East 45th St., New York 17).

Engineering Operations

"Fundamentals of Chemical Engineering Operations," by Maurice G. Larian, discusses the various stages of material processing with an aim to answering not only "what" unit operations to apply and "why", but also "how" these unit operations work.

This book is intended to help an engineering student pursue industrial employment with sound engineering judgment. It is written from a practical viewpont, and includes reference to engineering economics, illustrated by appropriate examples. Written in three sections, it discusses general principles, separation of mixtures by interphase mass transfer operations, and mechanical separations of heterogeneous mixture.

(Larian, Maurice G., *Fundamentals of Chemical Engineering Operations*, Prentice-Hall Book Co., Inc., Englewood Cliffs, N. J., 644 pages, $10.50.)

Feedwater Heaters

"Feedwater Heater Standards" contains new material relating to the design, construction and installation of feedwater heaters. This new material, and revisions in the second edition, were compiled by the Technical Committee of the Feedwater Heater Manufacturers Association.

The new publication, bound in semi-flexible simulated leather, is designed to permit easy insertion of addenda.

(FHMA, *Feedwater Heater Standards*, Feedwater Heater Manufacturers Assn., Inc., 53 Park Place, New York 7, N. Y., 22 pages, $2.00).

Clear Drawing Guide

A 32-page manual, "Drawing For Good Reproduction", just published by the National Association of Blueprint and Diazotype Coaters, stresses the importance of good draftsmanship and suggests techniques for improving reproduction.

Written in three parts, the manual covers essential elements of good reproducible documents, their preparation and care; prolonging the useful life of reproducible documents; and a brief description of reproduction processes and materials.

Since an original drawing seldom is used except for making reproductions, the quality of the reproductions is crucially dependent upon the quality of the original itself.

(Rau, Arthur H., *Drawing for Good Reproduction*, National Association of Blueprint and Diazotype Coaters, 1757 K St., N. W., Washington 6, D. C., $1.00).

Expansion Joint Standards

The Expansion Joint Manufacturers Association has just released a newly developed edition of Expansion Joint Standards. It contains up-to-date information concerning the design, construction, application and testing of expansion joints for piping and other services. Much of this information has never been published in any text or reference book.

The new material and data contained in this first edition of Expansion Joint Standards was compiled by the Technical Committee of the EJMA under the chairmanship of Harvey A. Weinberg, engineer of The Foster Wheeler Corp., New York.

(EJMA Technical Committee, *Expansion Joint Standards*, George P. Byrne, Secretary, Expansion Joint Manufacturers Association, 53 Park Place, New York 7, N. Y., $1.00).

Composition of Oils

"Symposium on Composition of Petroleum Oils" is a compilation of papers and discussion of a symposium held under the auspices of Research Division IV on Hydrocarbon Analysis of ASTM Committee D-2 on Petroleum Products and Lubricants. The Symposium on Composition of Petroleum Oils, Determination and Evaluation, was held in New Orleans on February 8-9, 1957. The contents of this ASTM special technical publication represents the latest knowledge gained from separating and identifying the less volatile liquids of petroleum.

(ASTM Committee D-2, Research Division IV, *Symposium on Composition of Petroleum Oils*, American Society of Testing Materials, 1916 Race St., Philadelphia 3, Pa., 288 pages, $5.50.)

Organic Synthesis Text

"Unit Processes in Organic Synthesis" is virtually a complete rewriting of a successful book. It is intended for readers having a sound training in physics, physical chemistry, and mathematics. In the discussion of each unit process, there is first a survey of the field; then the chemical, thermodynamic, kinetic, and engineering factors are discussed. This is followed by a description of equipments and materials of construction; finally examples of industrial applications are presented.

(Groggins, Philip H. (Editor), *Unit Processes in Organic Synthesis*, The McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y., 1070 pages, $17.50).

Technical Report Catalog

Two catalogs of technical reports have just been published by the Office of Technical Services, U. S. Department of Commerce.

Many of the reports listed in the catalogs are the result of research conducted for the Army, Navy, Air Force, and other agencies of the U. S. government. Others are German documents captured by the Allies during World War II.

(OTS, Catalogs of Technical Reports, *CTR 346, Polystyrene, 1930-58, and CTR 345 Greases and Lubricants, 1939-58*, Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., $.10 each.)

Compressor Specifications

Availability of Tentative Standard 617, "API Specification for Centrifugal Compressors for General Refinery Services," has been announced by the API. This is the first edition, June, 1958. It covers the minimum requirements for basic design, materials, inspection, and tests for centrifugal compressors used in refinery services handling air or gas, but excludes machines developing less than 5 psi. The specification covers motor, steam, or gas turbine, and engine driven compressors, and related lube-oil and shaft-sealing systems, controls, auxiliary equipment, and gear units.

(API, Tentative Standard 617, API Specification for *Centrifugal Compressors for General Refinery Services*, American Petroleum Institute, 50 West 50th St., New York, N. Y., 29 pages, $1.50).

Butt-Welding Standards

Two new revisions of American Standards are now available. One, American Standard B16.9-1958, covers over-all dimensions, tolerances, and markings for wrought and cast-carbon and alloy-steel welding fittings. The other, American Standard B16.25-1958, covers the preparation of butt-welding ends of pipe, valves, welding neck flanges, and pipe fittings. It is also applicable to other piping components which are connected into the piping system by butt-welding. The standard includes requirements for re-entrant shapes for heavy wall ends, welding bevel profiles, inside contours for joints made with or without backing rings, and machining dimensions with their tolerances.

(ASA, *Steel Butt-Welding Fittings, American Standard B16.9-1958*, ($1.50) and *Butt-Welding Ends, American Standard B16.25-1958* ($1.00), American Standards Association, 70 East 45th St., New York 17.)

. . . BECAUSE quality counts in the long run

1. Seamless and weldless construction.
2. Made from new, full weight material.
3. Uniform length and shape.
4. Accurate threads—beveled for easy starting.
5. Square faced ends.
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What's New in Equipment . . .

. . . and Manufacturers Literature

Refinery Operating Guide Goes On Line

An Operating Guide computer system, the first installation of its kind in the process industries, has been successfully placed on-line at a catalytic cracking unit in Esso's Baton Rouge refinery. The system measures 160 process variables of which 27 are computed operating guides such as catalyst circulation rate, carbon burning rate, material balance, etc. The system incorporates a Royal Precision LGP 30 general purpose digital computer.

In addition to calculating operating guides, the system prints off-normal conditions, and furnishes on-demand, hourly, daily log sheet summaries of process operation.

Esso's project coordinator states that the system is not only expected to enable the operators to improve process performance, but also will be used to develop techniques for ultimately "closing the loop." Leeds & Northrup Co.

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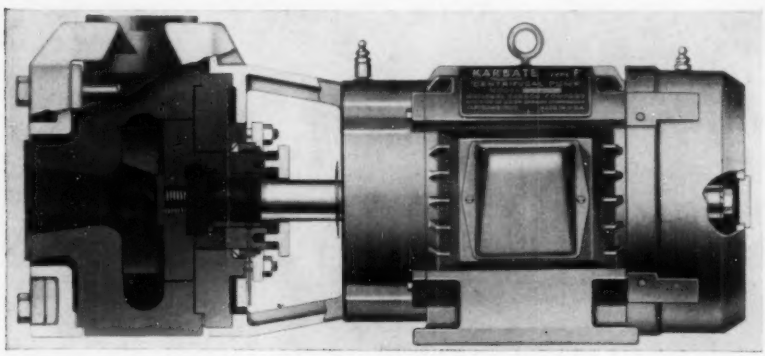


Graphite Pump Capacities Are Doubled

Three new sizes of corrosion-resistant centrifugal pumps, two with nearly twice the capacity of present models, have been added to the line of Karbate impervious graphite pumps. Increasing use of this motor-mounted type F pump has created a demand for a greater capacity range, both in terms of total head and gallons-per-minute ratings.

Known as models 22-FAL, 28-FAL, and 31-FAL, the new pumps are equipped with 1, 1½, and 2-hp, 1750-rpm motors. At this speed, the latter two types can deliver up to 150 gallons per minute compared to 80 gpm maximum for previous type F Karbate impervious graphite pumps.

The two larger pumps are available with 3 or 5-hp motors for handling fluids of higher specific gravity than water. Maximum total head for each of the new types is 33, 51, and 67 feet, respectively.

The almost universal corrosion-resistance of Karbate impervious graphite pumps makes these low-cost units ideal for a wide range of applications, and permits an appreciable reduction in inventories through the standardization of pumps and replacement parts. National Carbon Co.

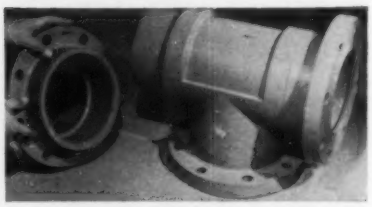
Circle E2 green card, last page

Molded Fittings for 6 Inch PVC Pipe Rated At 600 psi

A complete line of injection-molded unplasticized polyvinyl chloride fittings and flanges is now available for large-size (six-inch) UPVC piping. They were previously available in only the smaller sizes from ½ through 4 inches.

The new molded fittings safely withstand as much as 12 times higher pressure than more costly fabricated fittings customarily used to make directional changes in large-size UPVC piping.

For the first time, these 90-degree and 45-degree elbows, tees, reducing bushings, threaded and socket companion flanges and blind flanges make it possible for economy-



minded industrial engineers to utilize the full strength of light, economical UPVC piping in a large size.

The installed cost of UPVC piping with UPVC injection-molded fittings is at least 50 percent lower than the installed cost of lined steel pipe.

Because UPVC is only 1/6 as heavy as steel pipe and ½ as heavy as aluminum pipe, it is more economically transported to the job site, and its easy assembly cuts installation time.

Molded fittings have a burst strength of 600 psi, while fabricated fittings are rated much lower.

Among other advantages molded fittings have over fabricated fittings are greater resistance to bending stresses and other service conditions, better joints with optimum flow conditions, and a far wider range of corrosion resistance. This resistance is superior in most respects to that of natural and synthetic rubber often used to line steel pipe. Tube Turns Plastics, Inc.

Circle E3 green card, last page

New Technical Bulletin Describes Glycol Family

A forty-page technical bulletin on mono-, di-, tri-, and tetra-ethylene glycol has just been published. It presents a comprehensive review of the physical and chemical properties, and industrial uses

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DEKORON METL-COR / DEKORON POLY-COR + steel armor = ARMORED METL-COR / ARMORED POLY-COR — **FOR IMPACT AND CORROSION RESISTANCE**

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No matter what your special environmental requirements for instrument tubing may be—no matter how stringent for corrosion, impact or fire resistance—there's a type of Dekoron instrument line harness to *satisfy them exactly*. In most cases you can get *delivery from stock*. And *all* Dekoron products have three things in common: Highest quality materials and construction . . . lowest possible installation cost . . . longest life of any instrument line harness. That's *Dekoron—America's Premier Instrument Tubing Line.*

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of these four ethylene glycols. The manual, available for general distribution, also provides information on methods of shipment, specifications and analytical techniques required for determining product quality, and includes an extensive indexed bibliography.

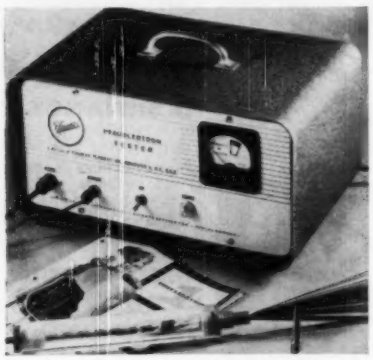
The glycols described find extensive uses as intermediates in the production of organic and inorganic esters, ethers, acids, and aldehydes. Characterized by their water solubility, hygroscopicity, moderate viscosity, and freezing point depression on water, the glycols find applications in the dehydration of natural gas, antifreeze and explosive formulations, resins, plastics, and plasticizers. Jefferson Chemical Co.

Circle E4 green card, last page

Glassed-Steel Equipment Easily Checked With Tester

A new, constant-voltage electronic tester, designed for non-destructive testing of surface continuity in glassed-steel equipment, has just been introduced.

The Pfaudlertron is the first completely electronic precision instrument specifically engineered for field testing glassed-steel



equipment. It has alrady been accepted as an industry standard.

Interior surfaces of glassed-steel vessels are occasionally damaged as a result of severe mechanical impact and should, therefore be inspected: (1) when equipment is originally received, (2) at the time of on-stream tie-in; and, (3) on any occasion when damage from physical impact or long term severe chemical service is suspected. Until the introduction of the Pfaudlertron, no testing unit was available that had been specifically engineered for field testing this equipment.

The Pfaudlertron can be plugged into a standard 110 volt AC outlet, and the twenty-five foot probe cord will provide access to all interior vessel surfaces. Control cabinet can be placed outside of vessel during inspection.

Testing procedure consists of methodically sweeping probe over all glassed surfaces. Brush-type probe is designed for rapid, convenient testing of open areas, while the pointed probe is ideal for use in valves, nozzles, and other restricted places. Brush probe allows 5 inch width to inspection path, yet each individual wire is capable of indicating contact. When a defect is detected, neon bulb in lucite handle will glow with unmistakable brightness. The Pfaudler Co.

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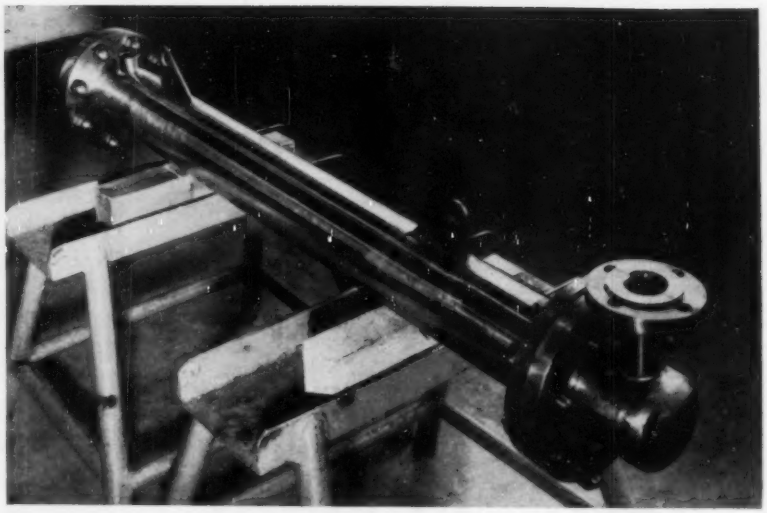


First Zirconium Heat Exchanger Fabricated

Zirconium has gained prominence in recent years due to extensive use in the atomic power reactor field. Because of particularly excellent corrosion resistance to concentrated acids and alkalies, interest is being aroused concerning other possible commercial applications. Specifically, its corrosion resistant properties made it appear admirably suited for fabrication of a wide variety of equipment used in the process industries.

Therefore, the world's first zirconium shell and tube heat exchanger was fabricated. The 11½-square foot unit has solid zirconium bonnets and tubes and zirconium lined tube sheets. The 4½-inch I.D. shell is constructed of polished type 304 stainless steel.

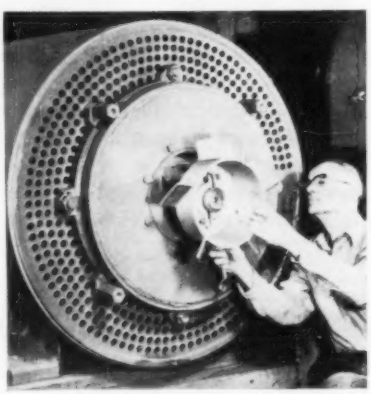
Many problems were confronted in fabricating the unit, for zirconium's working characteristics differ from most other metals. When cold formed it has a tendency to spring back to its original shape. Special techniques are required for welding: (1) it cannot be welded to any other metal, and (2) it has, like titanium, an affinity for atmospheric oxygen and nitrogen during the welding process. It was necessary to adapt techniques developed for working other metals to complete the project successfully.

The successful fabrication of the zirconium heat exchanger is significant because it places at industries service still another useful, corrosion resistant metal. The metal will resist all concentrations of hydrochloric acid at 100 F., sulfuric acid up to 80 percent, and most concentrations of nitric acid at 100 C. Zirconium is unique in its ability to resist attack by both acids and alkalies used alternately. It is also well suited for the fabrication of equipment used to produce concentrate solutions of hydrogen peroxide since this chemical will not decompose in the presence of zirconium. The Pfaudler Co.

Circle E6 green, card last page

Tube-Type Motors Are Rated Through 500 HP

Tube type, totally enclosed, fan-cooled squirrel-cage motors are being offered in polyphase ratings through 500 horsepower. Efficient cooling is provided in these fabricated steel frame motors by a series of tubes through which outside air is forced by an external blower. An internal



blower at each end of the rotor circulates the warm air inside the motor through ducts in the rotor and stator and around the cooling tubes, to hold the temperature rise within the specified limit.

Standard enclosed motors are built with Class A insulation for 55C. rise or with Class B insulation for 75C. rise. Explosion-proof motors are built with Class A insulation only and have Underwriters' Laboratories approval for operation under classified hazardous conditions. Motors can be supplied bearing labels for Class I, Group C and D, or Class II, Group E, F, and G locations.

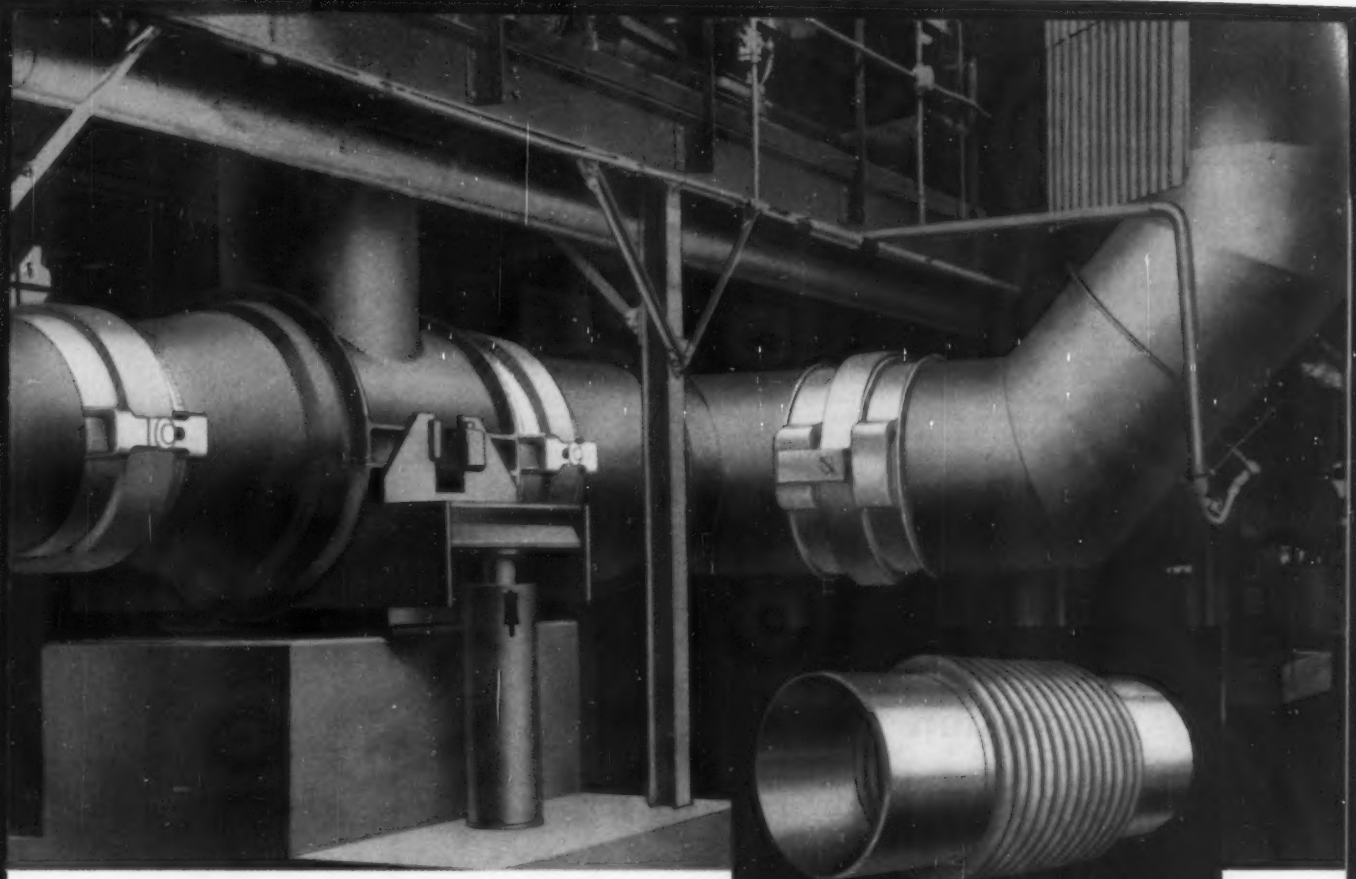
Standard models are designed with steel-backed babbitt-lined sleeve bearings lubricated by the oil ring method. Wagner Electric Corp.

Circle E7 green card, last page

Forged Steel Globe Valve Constructed For Long Life

A round bolted bonnet bolted gland globe valve has been added to a general purpose line of valves for 150-800 pounds service. They are available with screw ends or socket weld ends in ¼-inch through 2-inch sizes.

All valves have forged steel bodies with integral seats hard faced with Stellite or



View of hydrocarbon outlet line just below reactors shows three of a total of 67 Badger S-R Expansion Joints at Firestone's new Butadiene Plant at Orange, Texas. Joints shown are equipped with guide bars and external covers.

Series 50W S-R Expansion Joint
Shown with cover removed

Badger S-R Expansion Joints handle rugged 1100° service at Firestone's new plant

The Houdry process used at Firestone Tire and Rubber Company's new Butadiene Plant calls for temperatures up to 1100°. Add critical forces on anchors and connected equipment, wind loading, and complex piping arrangements and you have real problems in piping and expansion joint design.

Working together with Catalytic Construction Co. and Firestone, Badger solved these problems with new Service-Rated (S-R) Expansion Joints. In all, sixty-seven joints have been installed, all of the new Series 50 (low pressure) S-R design. Ranging in size from 30″ to 72″, the joints are arranged singly or in systems of hinged and tandem types to absorb and control pipe line movement (which, due to the piping arrangement, is often axial and lateral — in *two different directions*). Stainless steel bellows are used in all joints; welding nipples are stainless or carbon steel depending on temperatures to be encountered.

Here is another example of a severe pipe expansion problem Badger S-R Expansion Joints and engineering experience have solved successfully. Find out more about the ways they can help you — write today for illustrated brochure.

New corrugation and ring designs produce better equalization, "all-curve" flexing

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced... life increased.

Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer life.

Series 150 corrugation and ring cross-section

BADGER

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EXPANSION JOINTS

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its equal. Discs are 13 percent chrome stainless steel, hardened to give maximum resistance to wear and erosion. Other trims are available. Yoke nuts are of special high melting point alloy material for prolonged wear resistance.

Stuffing boxes are extra deep for longer life of packing and they have one-piece, forged steel packing glands. Packing gland studs and nuts are stainless steel.

Gaskets are stainless steel, spiral wound, asbestos filled and are unexcelled for high temperature, and high pressure services.

All valve parts are precision machined to close tolerances for drop tight operation. Henry Vogt Machine Co.

Circle E8 green card, last page

Better Drawings Combine Photography and Drafting

Easier and more effective use of engineering drawings has been made possible with the introduction of Photoneering, a new process that combines photography and drawings.

Specifications can be drawn directly on a photograph taken from any angle or point of perspective. A special heat and humidity resistant plastic film sheet is used, which permits necessary changes or erasures.

A four page brochure explains how Photography and Drawing combine to save time and money, and make engineering drawings easy to visualize with minimum interpretation. Technical Reproduction Service.

Circle E9 green card, last page

When Was Zinc Chromate First Used in Corrosion Inhibitors?

Over 10 years ago, in 1947, Wright introduced the use of zinc, for corrosion control, in a new Wright product called Penechrome Z. Since then other Wright Penechromes, containing zinc chromate and organic additives, have proved in years of field service the greater effectiveness of zinc-containing corrosion inhibitors. Wright research, as always, will continue developing new approaches to the solution of your water side corrosion problems.

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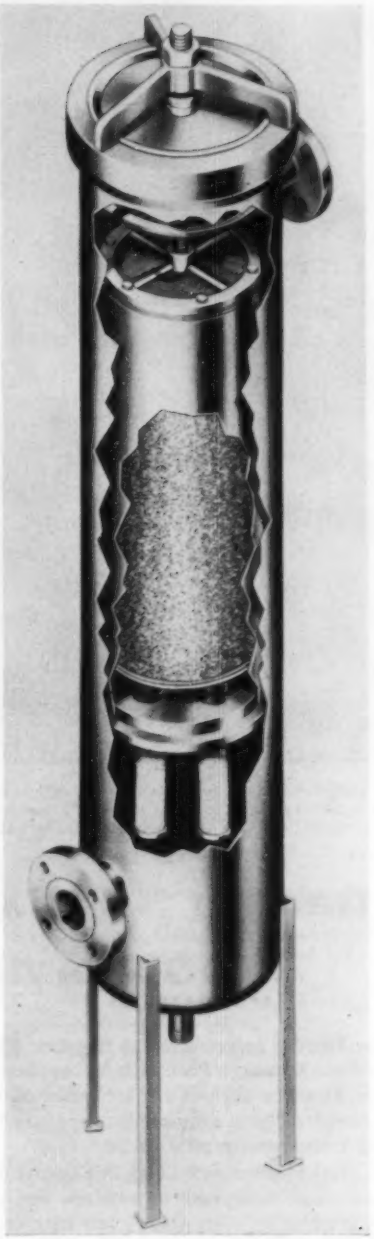


Adsorber Provides Clean Dry Air Free of Oil Vapor

The Vape-Sorber, a hydrocarbon vapor adsorption device that provides clean, dry air and gas for petroleum refineries and industrial gas manufacturers, is now available in 14 standard sizes—11 for normal pressure applications, 3 for high pressure applications.

The Vape-Sorber utilizes the basic principles of capillary physics and surface chemistry for effective liquid-gas separation. It operates in two stages:

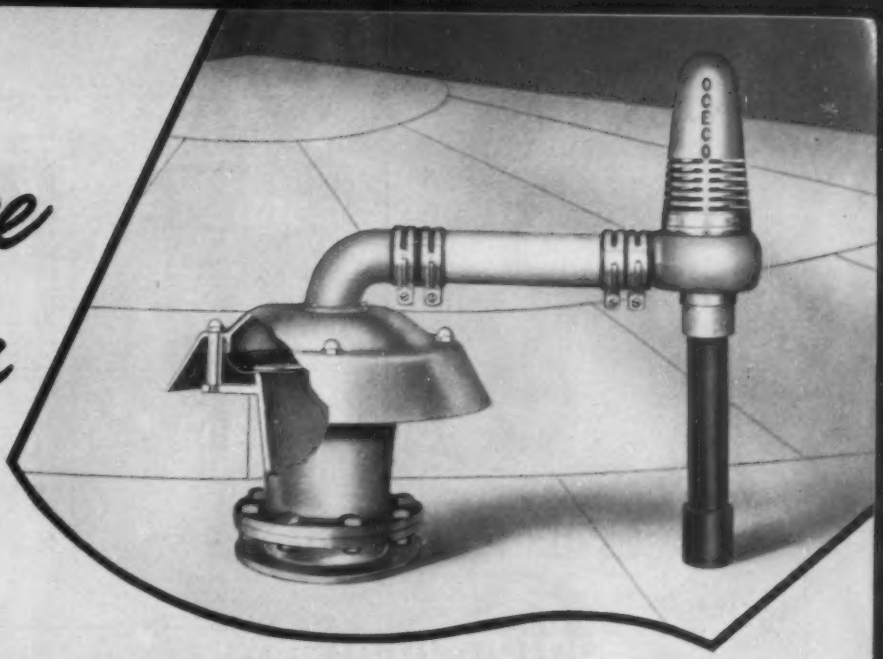
(1) Automatically removes water, water-oil emulsion, free oil in droplet form and dirt from compressed air or gas lines.

(2) Removes oil vapor and free oil in the form of mist and fog by passing the compressed air or gas through an effective adsorbent. The units are designed to allow

For more data on advertised products, use Readers' Service Cards, last page.

Reduce Vapor Losses

WITH



OCECO SERIES V-150

Pilot Operated RELIEF VALVES

For Cone Roof and Other Low Pressure Tanks

They Pay for Themselves By Saving the Vapors Other Valves Waste

Conceived and developed by Oceco engineers, Oceco Series V-150 pilot operated pressure and vacuum relief valves reduce tank breathing to the minimum—and increase product savings to the maximum — that the pressure and vacuum characteristics of the tank will permit.

These new valves do not open until the pressure in the tank reaches the pressure setting of the pilot, or the vacuum in the tank reaches the vacuum setting of the valve. This is unlike conventional valves which start to open at low pressure, so as to build up to full rated flow, within the safe operating pressure of the tank; and thus permit substantial amounts of vapors — and product — to be vented from the tank — and lost — at less than the tank's safe working pressure. Records of Oceco V-150 valves in service, on tanks, prove that they pay for themselves in 7 to 8 months, by saving the vapors that other valves waste.

As shown in the illustration, the system consists of a valve mounted on a tank, connected through a 3″ diameter aluminum tube to the pilot, which is also mounted on the tank. Pressure in the tank is applied against the **bottom** of the pilot valve — and through the tube to the large area on **top** the resilient membrane—keeping it tightly seated and preventing any "simmering" or "leakage" at less than set pressure.

The pilot, being very sensitive, opens full the instant the tank pressure reaches its set pressure, evacuating vapors from the top of the membrane, which opens instantly to **full flow** position, releasing tank pressure. The pilot closes automatically when the pressure in the tank has been released, reseating the valve membrane tightly again and shutting off the flow. Furnished in 6″, 8″, 10″ and 12″ sizes with low pressure (½ Oz. to 8 Oz.) or high pressure (½ Lb. to 15 Lb.) pilots, and with either open or closed type valve housings.

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New Equipment . . .

for sufficient contact time to enable adsorbent to effectively pick up all of the oil vapor and free oil in form of mist and fog. Selas Corp. of America.

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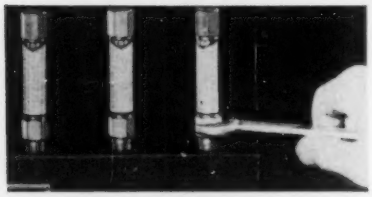

Manometer Check Valve Prevents Fluid Loss

A new manometer check valve which prevents loss of indicating fluid under any overrange condition has been developed. It is suitable for pressure up to 500 psig and for use with all manometer indicating fluids.

Manometer response and accuracy is not affected by the valve. "Air blocking" is prevented because maximum discharge is permitted until the instant the indicating fluid enters the valve. A Teflon float causes the tight closure of the specially designed stainless steel valve.

Measuring only 3¾ inches long and ⅝ inches in diameter, the valve is suitable for use on single-tube or on each tube of multiple-tube manometers. Connections are ¼ inches NPT; female at top and male at bottom. Meriam Instrument Co.

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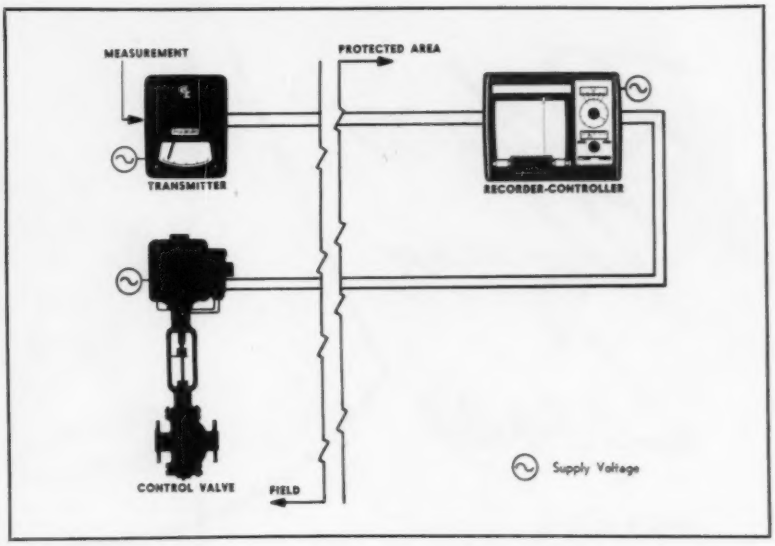


Control System Covers Process Functions

A full series of completely solid-state electronic control instruments has just been introduced. The new line, called Electronic Consotrol Instrumentation, consists of advanced design transmitters, recorders, controllers, and valve operators, covering every function in the process control loop. Typical process measurements such as pressure, flow, and level, are converted at the transmitters to proportional current signals and instantaneously transmitted over unshielded lines to a control center. Converters for EMF and resistance measurements also feed signals to the small case, panel-mounted receivers. In the same electrical range are the controllers and final operators which complete the loop.

Outstanding features of the instrumentation, in addition to the use of magnetic amplifiers and transistors, are: choice of

New Compact

conax®

THERMOCOUPLE HEAD with

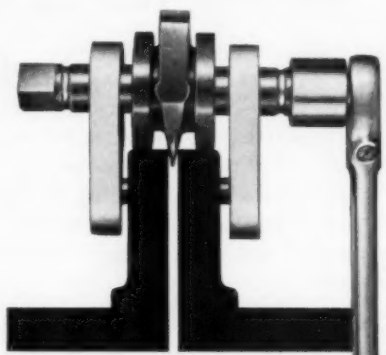
- **Light weight design**
- **Simple assembly**
- **Watertight construction**
- **Bright chrome finish**
- **Corrosion resistance**

for

use with 30 gage to 14 gage wire—maximum operating temperature of +300° F. (continuous) or +450° F. (intermittent). Ideal with Conax Thermocouple Glands, Conax Speedwells, Conax Flex-tube Assemblies, Conax Safetywells and other similar applications.

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS

conax corporation
2328 Walden Ave., Buffalo 25, N.Y.



A PIPE DREAM COME TRUE

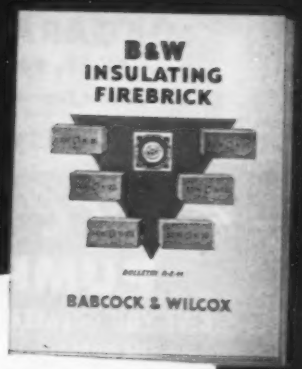
"SAFETY BOY"
AT LAST! A TOOL TO SPREAD PIPE FLANGES SAFER — FASTER — MORE ECONOMICALLY — IN TIGHTEST WORKING SPACE.

For Catalog Sheet, Write:
Wm. L. Riggs Co.
600 S. 129th E. Ave.
P. O. Box 5002
Tulsa, Oklahoma

With a "Safety Boy" you can spread all types of flanged pipe connections **in seconds,** not hours — to insert blinds, gaskets, orifices. Plant safety hazards and costly down time are eliminated by switching to this really modern pipefitter's tool — "Safety Boy." Wherever there's piping there's a need for "Safety Boy" — the handiest tool ever invented for work in cramped quarters. Lightweight and easy-to-carry, "Safety Boy" is reasonably priced for wide usage.

Why B&W IFB for Oil Heater Linings ?

- Lightest weight
- Simplified construction
- High hot load strength
- Lower conductivity
- Lower heat storage
- Better process control



The light weight of B&W Insulating Firebrick provides savings in capital investment in several different ways. The light weight of B&W IFB permits thinner wall constructions of equivalent insulating value. These thinner, lighter walls mean real savings in structural steel and concrete. Construction is further simplified because B&W IFB's high hot load strength makes possible higher unsupported walls without deformation at furnace operating temperatures. In addition B&W IFB can be cut and shaped with ordinary wood working tools, simplifying field installation.

The light weight of B&W Insulating Firebrick also provides the greatest insulation. Thus, they save more fuel.

Light weight also means lower heat storage. B&W IFB protect you against burn-out of expensive alloy tubing in the event of forced shutdown. B&W IFB respond faster to changes in firing rate, too, assuring you of more positive process control.

**Write for Bulletin R-2-H giving more data on B&W Insulating Firebrick.*

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

D-487

This Self-Contained Fluid Cooling System

...gives most accurate temperature control

NIAGARA Aero SECTIONAL HEAT EXCHANGER

Applied in cooling industrial machines or processes to temperatures approaching the ambient wet-bulb, the NIAGARA *Aero* HEAT EXCHANGER is independent of any more than a nominal water supply or disposal. The coolant system is a closed one, free from dirt and maintenance troubles.

Heat is removed from your process *at the rate of input,* giving you precisely the temperature you require and assuring the quality of your product. Heat may be added to prevent freezing in winter or for better control in a warm-up period. Liquids or gases are cooled with equal effectiveness.

Heat is rejected outdoors. Only the little water evaporated on the cooling coils in the air stream, or discharged to prevent hardness build-up, is consumed.

Niagara sectional construction saves you much installation and upkeep expense, gives full access to all interior parts and piping. Your equipment always gives you full capacity and "new plant" efficiency.

Write for Niagara Bulletin No. 132 for complete information

NIAGARA BLOWER COMPANY

Dept. PR-10, 405 Lexington Ave., New York 17, N.Y.

District Engineers in Principal Cities of U. S. and Canada

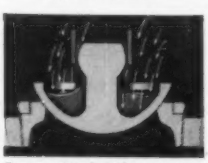
It's easy to see why

Royal Crown PUMP VALVES

...GIVE YOU GREATER PUMP CAPACITY AND INCREASED PUMP EFFICIENCY

Round valve surface is streamlined. No obstructions to restrict the flow.

Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing... a continuing perfect seat.


Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

Look at the illustrations at the right and you can see why ROYAL CROWN PUMP VALVES give such outstanding performance. These valves are guided by a frictionless ball stem (not a rigid guide). This allows them to oscillate and turn freely with the fluid stream with a minimum of resistance to the fluid. The result... greater pump volume at less pump speed. ROYAL CROWN VALVES swing free, with each stroke of the pump, seating perfectly every time in a new position. This means longer valve life and maximum pump efficiency. Get all the facts today on this revolutionary valve.

OUTSTANDING FEATURES

● Handles all types of oil products from high test gasoline to crude oil ● Adaptable to all reciprocating type pumps ● No crossbars in seat to restrict flow ● Valve cannot bind in any position ● Valve releases and seals flow instantly

THE PUMP VALVE WITH 1000 SEATS
EACH TURN... EACH SWING — A PERFECT SEAT.

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BALDWIN-LIMA-HAMILTON
CONSTRUCTION EQUIPMENT DIVISION

14120 E. ROSECRANS AVE., P.O. BOX 38, LA MIRADA, CALIFORNIA

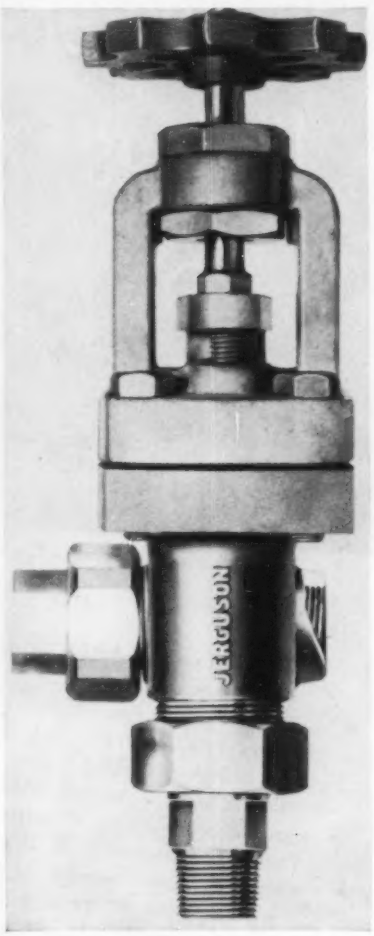
New Equipment . . .

motion balance or force balance transmitters; electrical measurement converters, entirely tubeless and mounted for front-of-panel accessibility; a completely new approach to control station design; and diversified installation arrangements using standard system components.

Other features of the instrumentation include: d-c transmission so that unshielded leads can be used throughout with no effect from a-c pickup; a current system unaffected by changes in line or load resistance induced by ambient temperature.

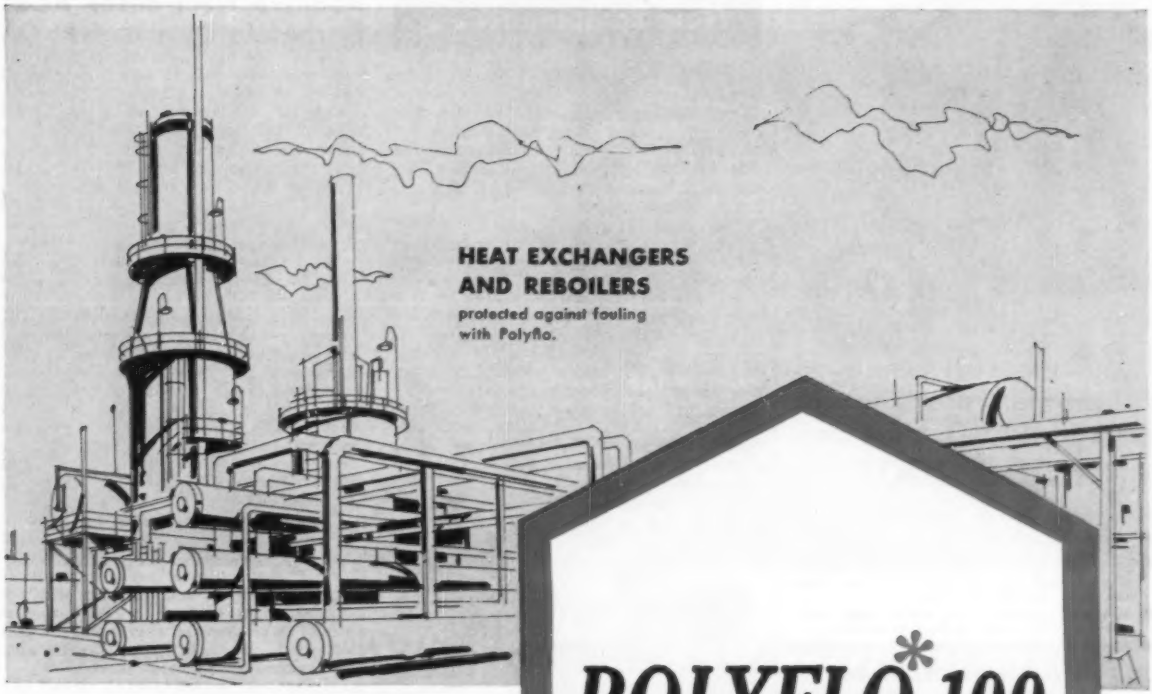
Also: pull-out construction so that key sub-assemblies can be inspected or replaced with minimum disruption of system operation; and optional explosion-proofing to comply with the requirements of Class I, Group D, Division 1, and Division 2 locations. The Foxboro Co.

Circle E12 green card, last page



OS&Y Valve For Use With Level Gages & Instruments

A new, improved type of outside screw and yoke bolted bonnet valve, for use with liquid level gages and instruments has been developed. This new bolted bonnet uses a forged yoke which supports the stem away from the valve body, and a separate forged gland-follower which bears



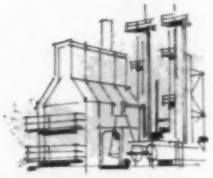
NOW... POLYFLO* 100

1 Multi-purpose Inhibitor-dispersant solves 5 pressing problems

A highly convenient all-around inhibitor-dispersant, UOP Polyflo 100 is also an effective stabilizer against thermal changes, color deterioration, sludge and deposit formation.

An effective dispersant for distillate, residual and crude oils, Polyflo 100 also eliminates fouling and sludge formation in heat exchangers and storage tanks.

Polyflo is but one of a variety of inhibitors and additives developed by UOP for petroleum refiners. Write our Products Department for detailed information on these products. Ask also about the services of our staff of treating field engineers, who will gladly work with you to solve specific problems.



No. 2 HEATING OIL
stabilized against color deterioration and sludge deposition.

DIESEL FUELS
also effectively stabilized with Polyflo.

OIL STORAGE TANKS
for distillate, residual and crude oils—kept free of tank bottoms.

JET FUELS
attain thermal stability with Polyflo.

* TRADEMARK

UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

Model W Electrolytic Moisture Analyzer
Explosion-Proof Model

Measures water content better than 1 part per 1,000,000!

Some Useful Applications:

- Continuous or batch analyses of water in a wide variety of gas and liquid streams—including process streams, inert atmospheres required in plant processes and laboratory dry boxes, and plant instrument streams.
- Measuring reaction rates where water is involved as a reactant, product, or catalyst.
- Studies of moisture permeability of polymers.

Write for complete information

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Since 1915
CONCRETE
SAND AND CEMENT
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Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
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2440 Pennway Phone GRand 1-2570

New Equipment . . .

directly on the packing and is entirely independent of the yoke. This construction places the threaded portion of the stem outside the valve body where it is not affected by temperature or nature of the liquid being handled. The design allows the valve stem to work freely at all times and prevents possible freezing.

Valves constructed with this new OS&Y bolted bonnet are available for all pressures, in a variety of styles which include offset, double union and jacketed valves. Inlet connections are available in five styles, including union, flanged, socket welding, solid shank and spherical union. These valves are made for severe service, can be repacked under pressure, have renewable seats, and are available in special metals and with special packings. Valve trim is standard in stainless steel with carbon steel valve body and forged yoke, nuts, etc., rustproofed. Jerguson Gage & Valve Co.

Circle E13 green card, last page

Leak-Proof Needle Valve For Service to 10,000 psi

A new line of general purpose, low-priced forged needle valves for 10,000 psi service is now being marketed. These new Series 100 valves include several innovations in design and are guaranteed leak-proof through packing from non-critical vacuum to 10,000 psi (WOG) service.

Among the unique features of the Series 100 valves is a Nylon stem wiper that adds materially to the life of the valve's leak-proof O-ring stem seal, as well as preventing foreign matter from scratching or pitting the centerless ground stem, thus guarding against leakage at high pressures.

Other features of the valve include a safe, integral bonnet; forged carbon steel bodies in angle or globe patterns with a selection of male or female connections; and panel mounting. Handles are of the cross-bar type in diecast aluminum, painted red. Operating temperatures range from —40F. to 500F. Typical applications include use on hydraulic lines, air lines, manifolds, test stands and gaging. Hoke, Inc.

Circle E14 green card, last page

Additive Neutralizes Acid Formed In Burning Fuel Oil

To provide maximum efficiency in the burning of fuel oils, an entire "family" of fuel oil additives is now being offered.

One of the newest additives, which company officials say will help to eliminate sulfur and vanadium corrosion resulting from the burning of Bunker C fuel oil, is Petrosene D. This additive has a high neutralizing activity for acidic products formed when burning fuels high in sulfur, as well as an ingredient which reduces vanadium oxide deposits in marine and industrial boilers burning residual fuels high in vanadium.

An important member of the "family" is Petrosene C, a dispersant and corrosion inhibitor. Added to No. 4, 5, or 6 fuel oil, Petrosene C will help to eliminate the accumulation of sludge and of corrosive acid constituents in fuel oil tanks. It also is valuable as a supplementary dispersant-detergent in diesel engines, by minimizing carbon deposits on injector nozzle tips and piston rings and lacquer on pistons in valve stems.

An additive that has remarkable properties for emulsifying and dispersing settled water in a fuel oil tank is Petromix No. 9. Water that settles in fuel oil tanks tends to cause corrosion, and combines with organic sediment to form a sludge that is difficult to remove and that interferes with combustion. Petromix No. 9 can be used with residual or distillate fuel oils.

Of interest to refiners of diesel and domestic furnace oil is Petrosene B, a fuel oil dispersant-inhibitor for No. 2 fuel oils. A multi-purpose additive that functions as a color stabilizer, sluge inhibitor and dispersant and rust inhibitor, Petrosene B is non-emulsifying.

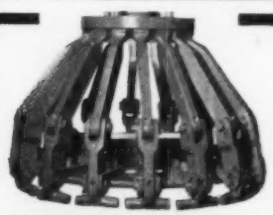
Full details on all these additives, plus recommendations for usage and results of actual field use and tests are contained in a series of new Technical Data Files. L. Sonnebon Sons, Inc.

Circle E15 green card, last page

Bulletin Covers Teflon Lined Pipe And Fittings

A new four page bulletin, T-S-1A, covering chemically inert, corrosion proof Teflon lined pipe and fittings has just been released.

The Fluoroflex-T Type S pipe and fittings assure a dynamically balanced rate

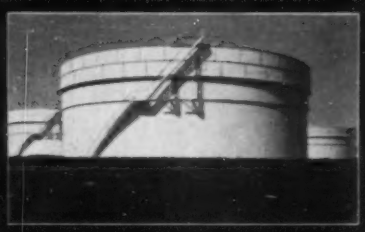


BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

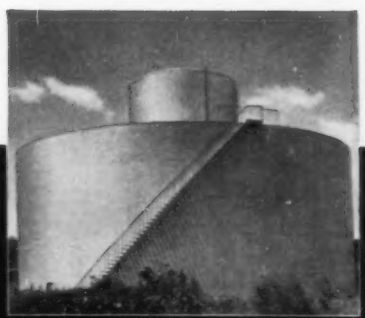
GRAVERSPHERES are used to store natural gasolines and volatile liquids including butane, butadiene, etc. They are ideal for storing gases—sustaining pressures up to 100 psi. and greater. Capacities range from 500 to 20,000 bbl.



GRAVER EXPANSION ROOF TANK eliminates breathing losses and minimizes filling losses. Its positive liquid seal, exclusive with Graver, protects under all conditions. Ideal for converting existing tankage, and simple to maintain, the Expansion Roof Tank may well protect an entire terminal.

there is a GRAVER *CONSERVATION DESIGN to fit every need!*

Graver manufactures a number of conservation designs allowing you to specify what suits your exact needs. Thus your tankage can be "tailor-made" to obtain optimum efficiency and maximum economy in operation. For authoritative assistance with your conservation problems, consult your nearest Graver Sales Engineer.



GRAVER VAPOR-MIZER is an economical design that conserves vapors, using less steel in building and requiring smaller vapor lines in manifolded tankage.
The VAPOR-MIZER helps maintain the fresh quality of your product! As it operates at very low pressures, the reinforcement of manifolded tanks becomes unnecessary.

GRAVER DOUBLE-DECK AND CENTER-WEIGHTED FLOATING ROOF TANKS are two separate designs in which the roof floats directly on the liquid, preventing the formation of vapors. They are applicable to crude and product storage areas at refineries, terminals and large bulk installations.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA • New York • Philadelphia
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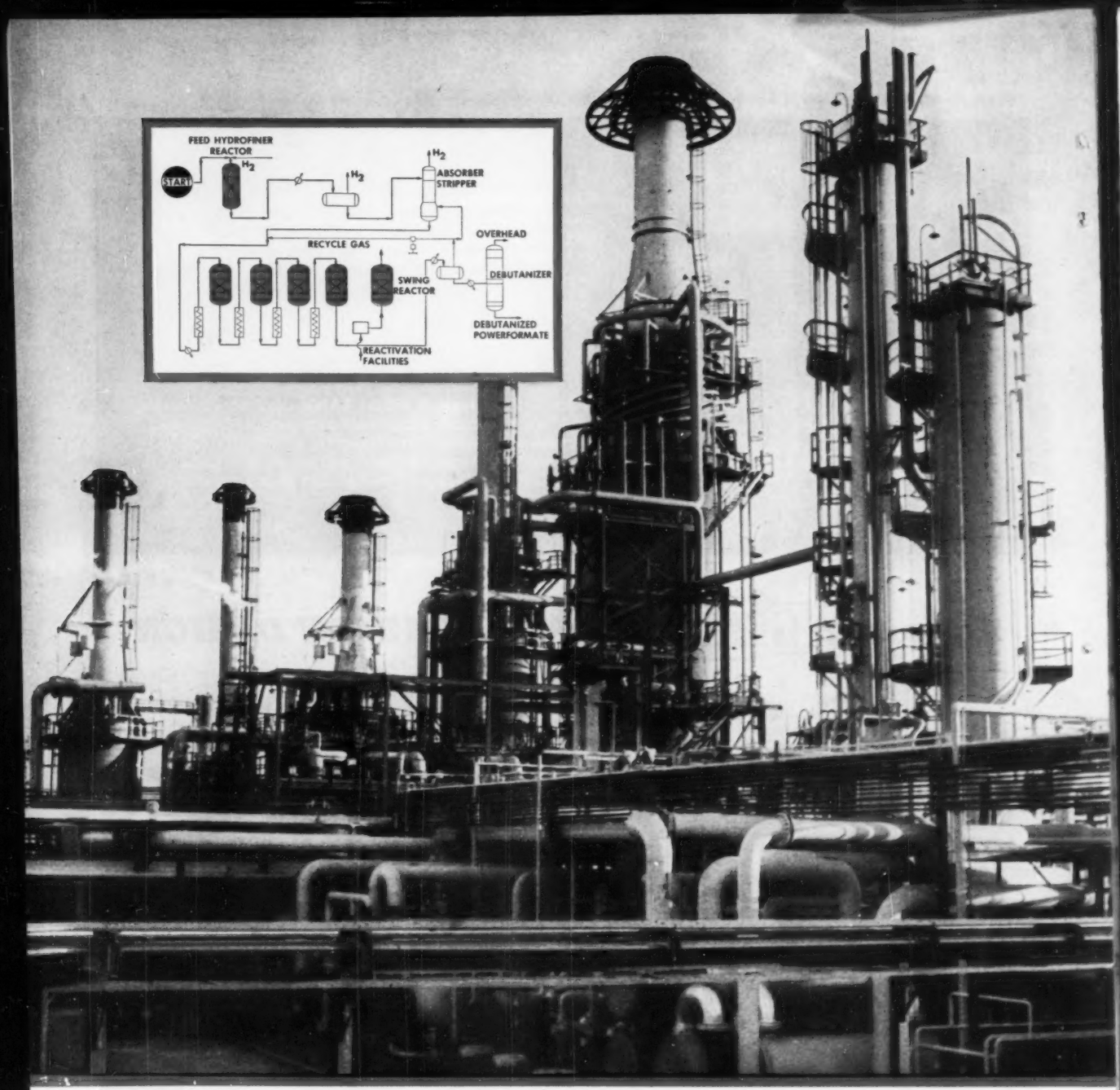
For more data on advertised products, use Readers' Service Cards, last page.



POWERFORMING PROCESS CAN INCREASE YOUR HIGH OCTANE YIELD

Esso Research and Engineering Company offers you *Powerforming*, the most versatile platinum reforming process ever developed. *Powerforming* is another achievement of the Esso Research program — 38 years of new process developments which have been made available to refiners around the world.

Heart of the *Powerforming* process is a new, more active platinum catalyst. High activity over a long life is assured by significant new regenerative techniques. With this new process, good yields of 100 octane clear Powerformate can even be obtained from paraffinic stocks. Twelve *Powerforming* installations are on stream; twenty-one are in the planning or construction stage. Licensees enjoy benefits of continuing *Powerforming* research. We would welcome your inquiry on the part *Powerforming* can play in *your* modernization plans.

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P.O. Box 243, Elizabeth B, N. J.

Your key to progress... an Esso Research process

New Equipment...

of thermal expansion-contraction between the housing and liner freeing them from the effects of thermal shock and fatigue stress.

Complete corrosion resistant piping systems which includes tees, short radius ells and reducing flanges are detailed as to size, flange diameter, thickness and mounting dimensions. Resistoflex Corp.

Circle E16 green card, last page

Tiny Dial Thermometer Solves Space Problems

The new "American," a 2-inch bi-metal dial thermometer provides mounting convenience without sacrificing visibility. The 2-inch dial solves space problems. On crowded installations it frees valuable space for other instruments. It will fit into locations too cramped for larger thermometers, into inaccessible places where temperature indication has been impossible, and into the best reading position despite obstructing piping.

Its low mass coil responds quickly to temperature changes. The coil is accurately centered and welded in the stem to eliminate retard effects which might be caused by rubbing against a side wall. The surrounding silicone fluid speeds heat transfer and dampens vibration. Standard ranges are from —80/120F. to 200/1,000F. and from —50/50C. to 100/500C. Accuracy is within 1 percent of range.

The 18-8 stainless steel case, ring and stem are erosion and corrosion resistant. The rigidly made stem gives tight closure against process pressures. The instrument may be installed anywhere, indoors or out, regardless of climate or atmosphere. Rugged—durable—and easy-to-read, the "American" 2-inch bi-metal dial thermometer offers maximum convenience and top performance at extremely low cost. Manning, Maxwell & Moore, Inc.

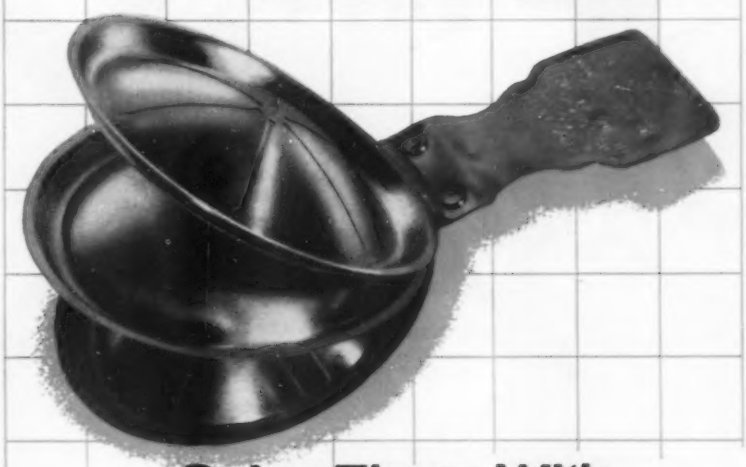
Circle E17 green card, last page

Precision Level Controller Uses Probe As Capacitor

Details of a compact pneumatic-electronic control device, said to detect and control changes in media, level with exceptional precision, are given in Technical Bulletin RF-587, just issued.

Consisting of a capacitance-sensitive probe and a controller, the Pneutronic Level Controller comprises a complete system for level control in a wide variety of liquids and granular media through precise pneumatic pressure output. Claimed to be valuable for application in vessels or small tanks which do not permit internal installation of conventional systems

"Difficult" Pressure Protection Problems?



Solve Them With...

BS&B *Safety Heads!*

BS&B's D and DV Rupture Discs, which are fully interchangeable in BS&B Safety Head flanges with conventional type pre-bulged discs, are engineered to give highly desirable Safety Head protection to those pressured systems in which one or more of the following "difficult" conditions prevail:

1. When operating pressure must be close to relief pressure.
2. When high operating temperatures are involved.
3. When alternating pressure and vacuum prohibits the use of standard one-layer rupture discs.
4. When pulsating pressure conditions prevail.
5. When a combination of metal and plastic disc construction is needed to obtain lower rupture pressures.

BS&B D and DV Rupture Discs have these advantages:

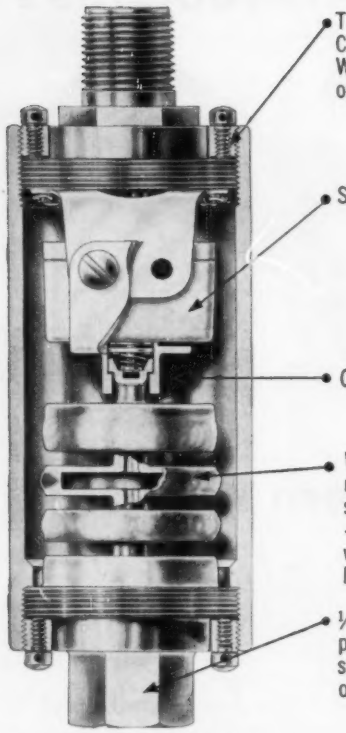
1. Fast action and unrestricted relief openings.
2. Wider rangeability in selection of metals and plastics for disc components.
3. Longer service life.
4. Rugged construction for added protection against possible damage by rough handling.

Let BS&B Safety Heads solve your pressure protection problems. Our engineers will gladly evaluate your pressure system to assist you in proper selection of Safety Heads.

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-F10
7500 East 12th Street
Kansas City 26, Missouri
Telephone: BEnton 1-7200

NEW PRESSURE SWITCH FOR **HIGHLY CORROSIVE** MEDIA


Threaded (adjustable) Construction Shown; Welded construction optional
Snap action Switch
Overtravel protection
Welded multiple diaphragm sensing element —not to be confused with an accordion bellows.
¼" internal pipe thread pressure connector is standard—Welding fitting optional.

SAVE EXPENSE OF CHEMICAL PROTECTORS...OFTEN MORE THAN THE PRICE OF THE PRESSURE SWITCH

This new tier-tube line of Meletron pressure switches is available in materials suitable for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, proprietary amine fuels, fluorine, mixtures of fluorine and liquid oxygen and others.

Proof pressures range from 224 to 6000 P.S.I., pressure settings from 2 to 4800 P.S.I. Switches will operate in temperatures from −65° to +275° F. Standard pressure port fitting is ¼" internal pipe thread but may be substituted by special welding fitting. The housing serves as a pressure tight safety capsule in case of a break in the sensing element. Single pole double throw switching elements are rated to 10 amps., for AC and DC circuits. Free leads or Cannon plug are optional for electrical connection. As an added safeguard, the stainless steel models will withstand 2000° heat for five minutes.

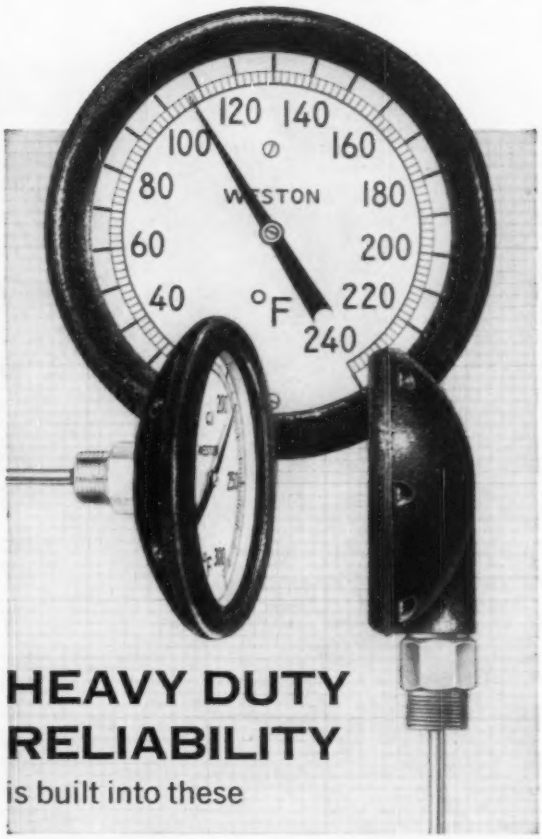
Write for bulletins 1110 to 1170.

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

WESTON THERMOMETERS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



HEAVY DUTY RELIABILITY
is built into these

WESTON BIMETALS

For lasting accuracy, even under punishing conditions, you can depend on Weston heavy duty bimetal thermometers. Exceptionally stable sensitive elements . . . corrosion-proof, pressure-tested stainless steel stems and connection nuts . . . rugged forged brass heads . . . suit these bimetals for the most strenuous service. Accuracy is assured within 1% of full scale range. 20 standard ranges: running from −100° to 1000°F or −100° to 400°C. Standard stem lengths from 2½" to 72".

Model 2221: has a 5" diameter head with 9" scale.

Model 2231: 6" diameter head with 12" scale.

Model 1221: straight form—basically the same as Model 2221, but with scale parallel to stem. Stem can be located in any one of 24 positions around the periphery of the head.

For full information, call your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

WESTON

A DAYSTROM UNIT

Instruments

New Equipment . . .

requiring large detection devices, the new control system is obtainable with weather tight or explosion proof control housings. Types are available for either overload or underload control. Compatible media include hydrocarbons, oils, acids, aqueous solutions and many granular products. Robertshaw-Fulton Controls Co.

Circle E18 green card, last page

Telescoping Foam Tower Elevated By Its Own Foam

A portable fire extinguishing appliance recently developed in London, will be of special interest to all concerned with the bulk storage of highly inflammable liquids.

This appliance, the 'Pyrene' telescopic foam tower, is automatically elevated by its own foam pressure from a mechanical foam generator, and ensures rapid top application of foam to storage tanks.

The foam column consists of three or four concentric light alloy tubes, according to the model specified. Between each section of tubing is a positive seal and guide ring, to prevent loss of foam and to ensure smooth operation of the elevation.

Attached to the column is a pair of bogie wheels, enabling the upper sections to run up the side of the tank. Pouring heads of different types are available to suit the kind of discharge desired and the design of the tank. If required, a wheeled chassis of light alloy construction with towing attachment may be fitted to provide transportation over service roadways.

In its standard form, the 'Pyrene' self-elevating foam tower is designed to extend a maximum height of 70-ft., but can be adapted, where necessary, to meet specific requirements. The Pyrene Co., Ltd.

Circle E19 green card, last page

Corrosion Resistant Coatings Made For Refinery Service

Described in new general information cal and technical bulletins just issued are details on protective coatings made specifically for the petroleum refining and petrochemical industry. The bulletin describes "Plasite" #7155 as a tank lining for 108 F. demineralized water in condensate receiver tanks, and as a protective coating for hot piping, cooling tower piping, fans and hubs, lining for Perco treaters. "Plasite" is suitable as a tank lining for storage and transportation tanks containing high octane gasoline, jet fuel, a wide variety of aromatic solvents and chloronated solvents. Physical properties include a tough abrasion resistant

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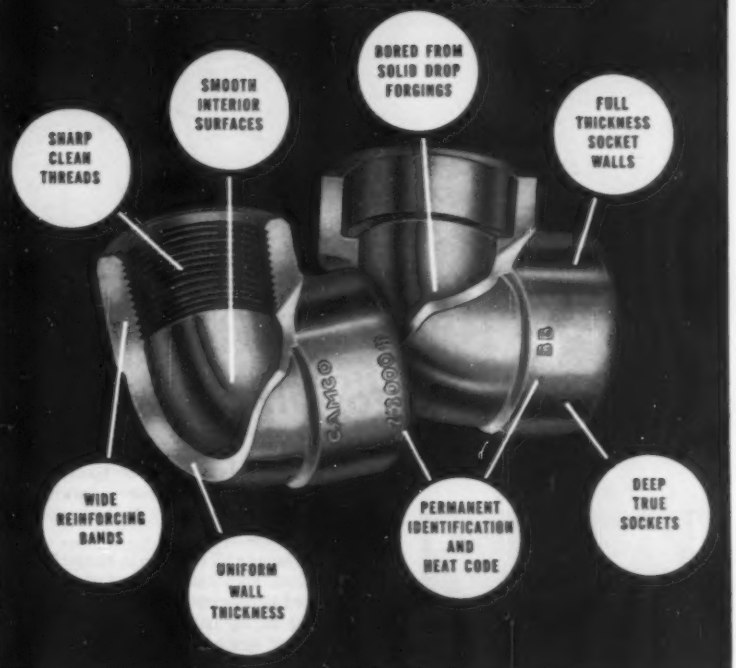

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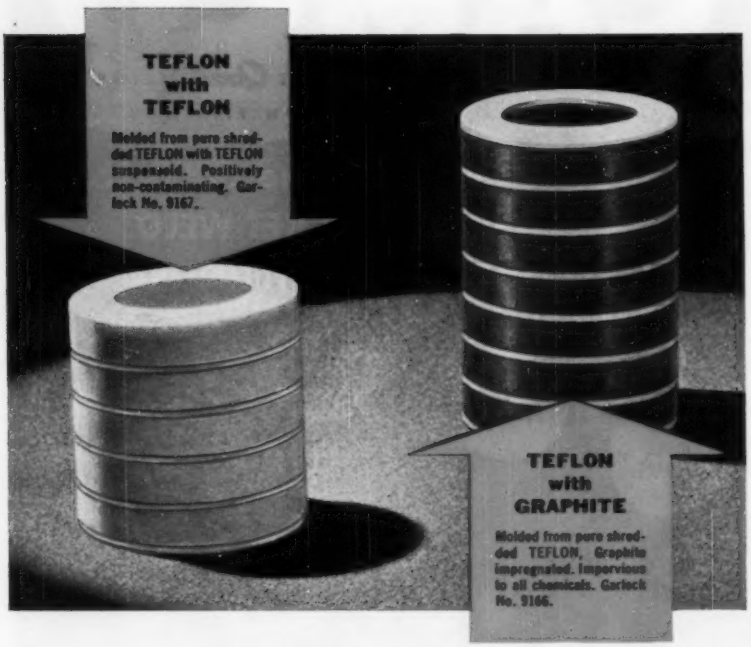
For more data on advertised products, use Readers' Service Cards, last page.

CHEMISEAL® PUMP PACKINGS
standard for corrosion service . .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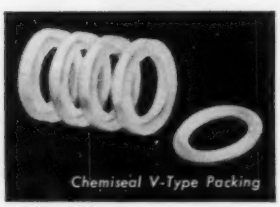

FOR VALVES

Solid TEFLON Ring packings are available in Chemiseal V-type, diagonal, triangular, conical and Garlock Chevron† ring designs—providing necessary seal at low gland pressure and reducing torque required to operate the valve.

Chemiseal TEFLON* Pump packings offer remarkably trouble-free service, and useful life many times that of other type packings.

Impervious to all chemicals, excepting only molten alkali metals and fluorine at elevated temperatures, these packings are giving highly satisfactory performance sealing against such difficult and hazardous liquids as sulphuric, chromic, nitric and hydrofluoric acids; chlorine, bromine, sulphur chloride, sulphur oxychloride, hydrogen fluoride and concentrated hydrogen peroxide.

Extremely effective for rotating and reciprocating shafts, Chemiseal TEFLON pump packings provide a low friction, 2-way seal that not only prevents axial seepage, but also seals against shaft and stuffing box as well. Supplied in sets to meet specific requirements.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write for Bulletin AD-155.

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film with excellent bond to blasted steel without the use of a primer. Heavy films from .008 inch to .018 inch are applied by standard methods using a minimum of two to three coats with resultant savings in time and labor. Wisconsin Protective Coating Co.

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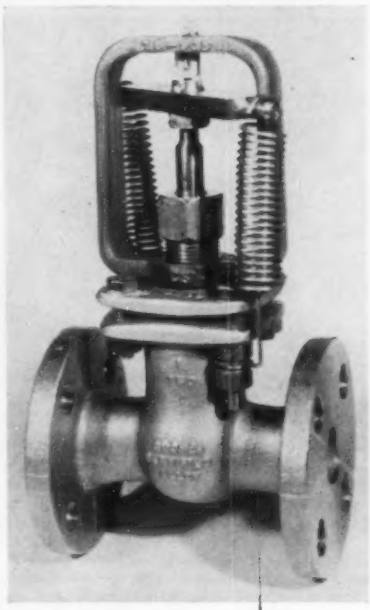

Fire Protection Gate Valve Guards Flammables

Simplicity is the key to the radically new fire protection cut-off valve being used to handle a wide range of corrosive flammables. Requiring neither a complex system of counterweights nor interior bellows, the stainless steel valve is essentially a modified bolted bonnet gate valve held open against two exterior springs by a small fusible link. These springs snap the valve shut when the fusible link reaches a melting temperature of 160 F., preventing the flow of liquid to fire areas.

At American Cyanamid's Linden plant where high tonnage organic and inorganic chemicals are produced, the valves are used in lines below storage tanks containing such combustibles as ethyl mercaptan, ethyl alcohol, methanol, acrylonitrile and methyl ethyl ketone. Made of 316 stainless to resist both interior and exterior corrosion, they can be used at pumping pressures up to 150 psi.

The old cut-off valves used at the Warner's Plant presented several problems. They were of two types. Both were complex. The first was operated by a system of counterweights which periodically "froze" in place because of atmospheric corrosion and required continual checking and maintenance. In addition, positioning of this valve was a limiting factor. Unless it was hung upright in a location large enough for the counterweights and supporting arms, the valve could not be used at all. The second type was operated by a system of interior bellows. With this valve, internal corrosion was the problem and careful maintenance and frequent and

difficult part replacement were required. A new valve, of simple design, durable material and construction and foolproof actuation was needed to overcome these limitations.

Since the fusible link is the key to the valve's operation and the one used is standard and Underwriter Approved, the test consisted of exposing the valve to various temperature levels and flames and observing that the mechanism operated as specified. With all tests completed satisfactorily, the first valves were put into service.

No problems have been experienced and the gate-type fire cut-off valves are now replacing the counterweight and bellows valves throughout the plant. They are inspected monthly and tested once a year. After testing, replacing the fusible link, held in place by two pins, is easy.

Virtually nothing can go wrong with the valve internally where there are no moving parts and the protective feature consists of only the two gate discs. Because of its compact size and lack of counterweights, space and position is no longer a limiting factor. The valve can be installed in any position in cramped or highly inaccessible plant locations.

Cost is another feature with which American Cyanamid personnel are well pleased. Despite the fact that the valve is a quality product made in stainless, the complete fire-protection valve is competitive in price with valves made of carbon steel.

Now being made on a production basis, the valve is available in alloy types 304, 316, FA-20 and nickel in sizes from ½" to 2". Springs are made of stainless steel. A special design feature is the rotating double disc assembly which maintains a tight seal even when the valve body distorts because of heat. A retained bonnet gasket for higher, more uniform loading, and a one-piece stem and disc carrier assure foolproof operation with the simplest design. Cooper Alloy Corp.

Circle E21 green card, last page

Probe Meter Controls Flow To Reduce Flare Losses

A bulletin just released describes the new Anemotherm, a probe-type gas flow meter. It is an electronic stainless steel probe meter for measuring, recording and controlling gas flow in the refining and chemical industries. Important advantages it offers are:

- Saves thousands of dollars per day in reducing flaring losses. Measurement of flow in the flare stack and its laterals will locate points of gas loss.
- Automatically controls any process when gas velocity sensing can be used through electric or pneumatic relays to control heaters, valves or similar devices.
- Improves pollution control. Waste gases can be reduced and steam for flare stacks can be saved by proportioning the steam flow according to the gas flow rate.
- Improves efficiency of chemical process by actuating alarms or signals when a change in gas flow indicates the loss of efficient control of a gaseous chemical process.
- Measures gas flow to furnaces and boilers to assure efficiency of combustion control.
- From one to 16 probes can be used with suitable recorders. Anemostat Corp. of America.

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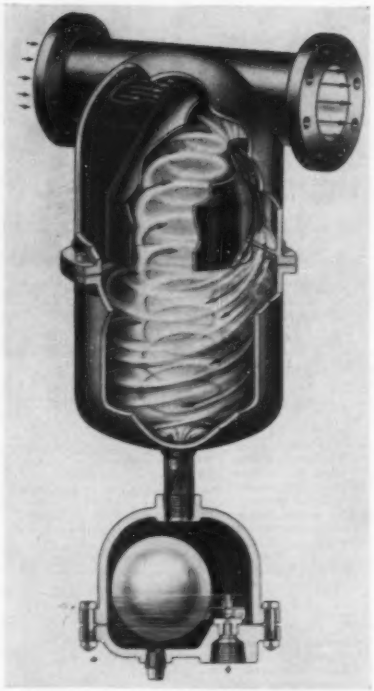

Centrifugal Force Used To Separate Entrained Liquid

The improved type "T" separator, designed for steam, air and gas applications, utilizes centrifugal force to separate moisture and oil entrained in the vapor flow. As shown in the illustration, the steam, air or gas is directed through an annular passage which increases its speed to produce maximum centrifugal force. The entrained matter which now clings to the outer wall drains to the bottom of the separator to an automatic trap. The entrance to the outlet chamber has been enlarged to provide for greatly reduced velocity at that point. This virtually eliminates re-entrainment problems associated with conventional separator designs.

The force of flow and simple bottom collecting section make this a self cleaning unit. The straight through pipe connections permit easy and inexpensive installation. The new improved type "T" Separator series is available with screwed connections through 3 inch and 125 pound ASA flanges through 8 inch pipe sizes. Wright-Austin Co.

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New Catalyst Produces High Octane Reformates

Commercial production of Type 3-G, a new, improved Houdriforming catalyst, has just been initiated. Type 3-G fulfills the requirements for a catalyst that will produce very high octane reformates. It enables refiners to gain these higher octanes at the same or lower catalyst cost than had been previously possible. Commercial operation using the new catalyst has been started by refiners.

The catalyst can be used in existing reformers. It is fully regenerable. At very high octane ratings, the rate of catalyst deactivation between regenerations (in situ) is extremely low, even at low recycle gas ratios. Houdry Process Corp.

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Engineering Data on Floor Gratings In Bulletin

A new, two-color, 16-page catalog on open floor grating and stair treads is now available.

The catalog features many product illustrations of rectangular grating with various wearing surfaces, Relgrit abrasive embedded non-skid grating, U-type grating, radial grating and numerous styles of treads.

Complete engineering details, from panel sizes, weights and safe loads, to surface treatments and fastening methods are included. Reliance Steel Products Co.

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Bulletin Covers Barometric Condenser Design Data

New Bulletin 5AA describes a line of barometric condensers for removing air, exhaust steam, and other vapors from vacuum equipment.

The bulletin covers condenser theory, design features, construction, operation, and application. The several types described include: multi-jet; multi-jet spray; multi-spray; and counter-current. Performance data is included in easy-to-read curve form with examples.

Tables give sizes, dimensions, and weights for all units described. Color sectional drawings are used to illustrate the equipment and explain operation. Schutte and Koerting Co.

Circle E26 green card, last page

Portable Hand Pyrometer Finds Surface Temperature

For the many situations requiring a simple method of measuring temperatures of various materials and surfaces, the Model B Portable Hand Pyrometer is now available. It requires no power source, special tools or operator skill. It may be used anywhere for measuring temperatures of convex, rotating or flat surfaces; for plastics, rubber or semi-fluids, liquids, gases or molten soft metals.

The pyrometer itself is offered in 12 scale ranges. All ranges are automatically compensated for changes in ambient temperature. West Instrument Corp.

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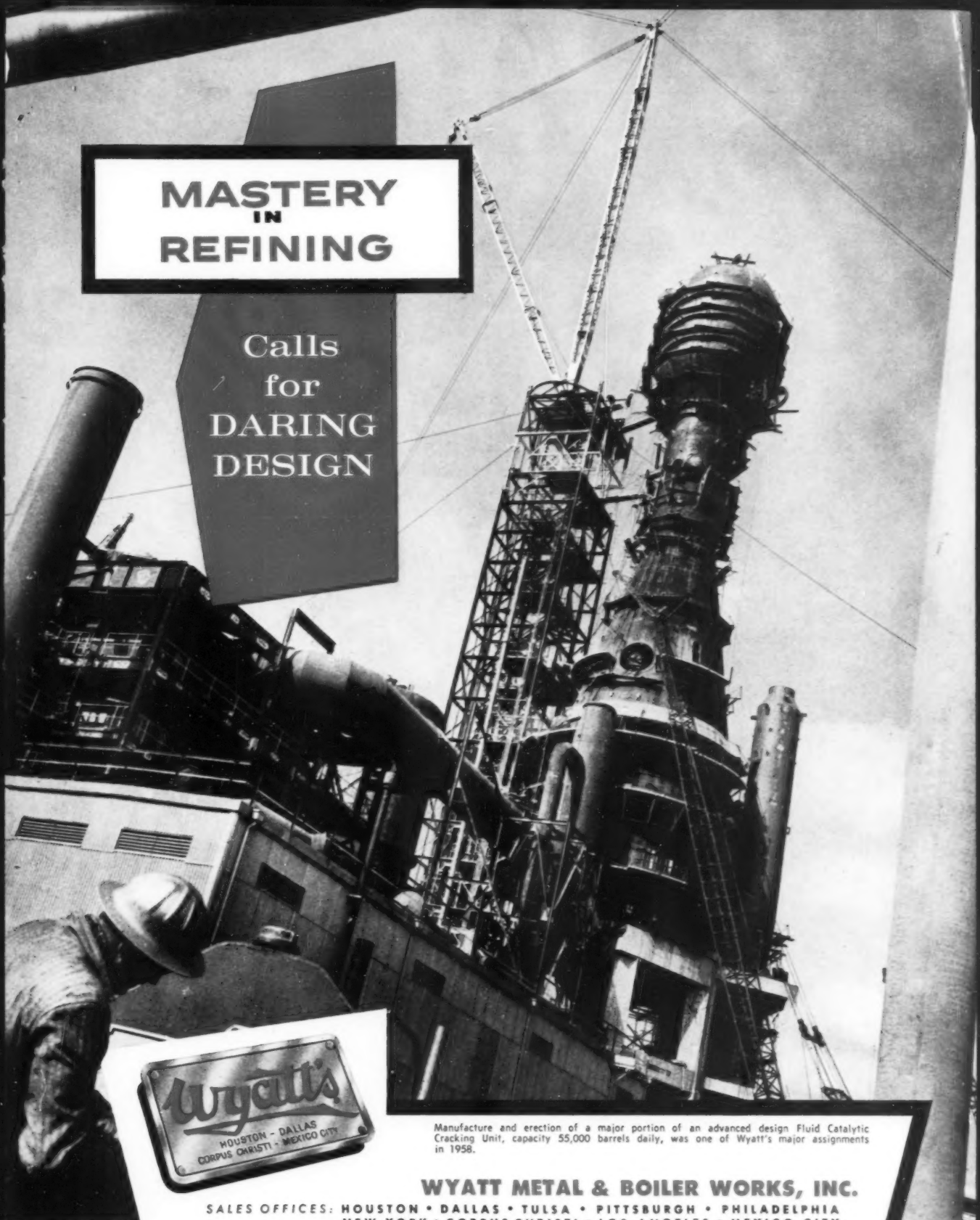

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